Defence Research and Development Canada
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# Public Security Technical Program Planning Scenario: Final Report

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DRDC CSS CR 2010-10

December 2010

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# Abstract

*Introduction:* Scenarios are critical to almost every aspect of Public Safety and Security (PSS) and Emergency Management (EM). Users within the stakeholder community, from policymakers to first responders, employ scenarios. They provide the context for requirements definition, options analysis and exercise design - characterizing the problem space, facilitating evaluation of response options and allow the introduction of new concepts and technology. To meet the needs of this diverse set of users, a framework has been developed to assist in selecting, sharing and exploiting planning scenarios. While the ultimate scope of application is much broader, the initial use of this framework is intended to support capability gap and options analysis as part of the Public Security Technical Program.

*Methodology:* The PSTP Planning Scenario Framework presented seeks to serve a range of stakeholders, from the national level to the community level in selecting scenarios based on user problems, objectives, risks and time. To develop the framework, there were three areas that needed to be addressed: a taxonomy for defining scenarios needed to be developed; dimensions for categorizing scenarios needed to be selected; and the framework itself needed to be populated with a selection of representative scenarios. Through a review of existing literature, a scenario was distinguished from alternate futures – long-term future trends – and from small, high-fidelity vignettes. For planning purposes, scenarios cover generic threats or hazards anticipated in the near future, including assumptions about context as well as capabilities. Each scenario within the framework was categorized based on a set of dimensions. These dimensions (including risk criteria, triggers, time horizons, etc) helped to define, access, and select scenarios.

*Way Ahead:* This project created a scenario set that has the potential to frame future S&T investment, through the PSTP, providing a common "yardstick" for evaluating S&T initiatives over time. The framework was also developed into a prototype relational database that could serve to provide greater access and use. Additional effort to mature the framework would help to promote scenario reuse and present a forum for capturing best practices and developing standards, thus improving efficiency and effectiveness of PSS and EM procedures from the community level up to national level.

# Résumé

## Rapport final sur le cadre de création de scénarios de planification du Programme technique de sécurité publique :

*Introduction :* Les scénarios sont essentiels pratiquement pour tous les aspects de la Sureté et de la sécurité publique et de la gestion des urgences. Tous les utilisateurs au sein de la communauté des intervenants, des responsables des orientations politiques aux premiers intervenants, utilisent des scénarios. Ils établissent le contexte pour la définition des besoins, l'analyse des options et la conception des exercices – notamment en précisant le problème en cause et en facilitant l'évaluation des possibilités d'intervention, et ils permettent l'introduction de nouveaux concepts et de nouvelles technologies. Afin de répondre aux besoins de l'ensemble des divers utilisateurs, on a élaboré un cadre afin de faciliter la sélection, la communication et l'utilisation des scénarios de planification. Bien que le champ d'application final soit plus vaste, le but initial de ce cadre est de combler l'insuffisance en capacités et d'appuyer l'analyse des options dans le cadre du Programme technique de sécurité publique.

*Méthodologie :* Le cadre de création de scénarios de planification du Programme technique de sécurité publique (PTSP) soumis vise à aider une gamme d'intervenants, à la fois à l'échelle nationale et à l'échelle locale, à choisir des scénarios en fonction des problèmes des utilisateurs, des objectifs, des risques et du calendrier. Pour élaborer ce cadre, il fallait effectuer les trois tâches suivantes : élaborer une taxonomie pour les scénarios de définition, choisir les scénarios de catégorisation et déterminer des scénarios représentatifs pour le cadre. En examinant la documentation disponible, on a distingué un scénario d'une gamme de scénarios possibles à l'avenir – les tendances futures à long terme – et de petites niches représentatives. Aux fins de la planification, les scénarios couvrent des risques ou dangers généraux prévisibles dans un proche avenir, y compris les hypothèses concernant le contexte ainsi que les capacités. Chaque scénario du cadre a été subdivisé en catégories en fonction d'un ensemble de dimensions. Ces dimensions (notamment les critères de risque, les éléments déclencheurs, les horizons temporels, etc.) ont permis de définir et choisir des scenarios ainsi que d'y accéder.

*Perspectives :* Le projet a permis de créer un ensemble de scénarios permettant de structurer l'investissement futur en S et T, dans le cadre du PTSP, en fournissant une référence commune pour l'évaluation des projets en S et T au fil du temps. Le cadre a été également présenté sous forme de base de données relationnelles prototype plus accessible et facile à utiliser. Des efforts supplémentaires pour améliorer ce cadre aideraient à promouvoir la réutilisation du scénario et offrirait un mécanisme de fixation des pratiques exemplaires et d'élaboration de normes, améliorant ainsi le rendement et l'efficacité des procédures de la Sécurité publique et de la gestion des urgences dans les collectivités locales et à l'échelle nationale.

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# Executive summary

## Public Safety Technical Program Planning Scenario Framework Final Report:

**Peter Race; Doug Hales; DRDC CSS CR 2010-10;**

**Defence R&D Canada, Centre for Security Science; December 2010**

## Background

Scenarios are a prime Public Safety and Security planning and training tool. For example, every user within the Emergency Management (EM) domain, from policymakers to first responders, employs scenarios in one form or another. Scenarios are used to: move Capability Based Planning from concept to practice, to define requirements and to inform and focus training. Scenarios characterize the problem space, evaluate potential response options, determine metrics and evaluate new technology. This initiative was raised as a contribution to the studies being conducted by the Public Security Technical Program (PSTP) in the Emergency Management Systems & Interoperability domain. It was realized that an objective framework is required to assist the PSS community in selecting and sharing PSS planning scenarios for use in defining capability gaps to inform Science and Technology investment. The same utility applies across the other domains in PSTP including the all-hazards risk assessment area, and so the context for developing a planning scenario framework was subsequently broadened to all public safety and security (PSS) capability areas (i.e. prevent, prepare, respond and recover).

## What is a Scenario?

Frameworks provide a structure for categorizing complex issues and organizing thinking. The EM Scenario Framework is designed to serve a range of stakeholders, from the national level to the community level. The framework helps users select scenarios based on their own unique problems, objectives, risks and time. As the framework matures, it will promote information reuse and present a forum for capturing best practices and developing standards, thus improving efficiency and effectiveness improvements both locally and nationally.

There is no common definition for the term scenario. For the purpose of this framework, a scenario was distinguished from alternate futures – long-term future trends – and from small, high-fidelity vignettes. For planning purposes, scenarios cover generic threats or hazards that could occur within the near future. They capture assumptions about context (e.g. political, social and economic conditions) as well as capabilities. Scenarios also include a situational description and a timeline. The final product is an account or synopsis of a projected sequence of events, or description of a course of action. The framework also includes a set of scenarios that span the range of PSS capabilities from preparedness to recovery (i.e. -3 to +3 time horizon); these “full-spectrum scenarios” provide context for planning, training and analysis.

Each scenario within the framework is categorized based on a set of dimensions. These dimensions help define, access, and select scenarios. The two main drivers are risk and

capability. Using the All-Hazards Risk Assessment (AHRA) approach methodology, the framework can be characterized based on stimulus or trigger, allowing selection of scenarios that have the highest probability of occurrence and the highest consequence. The capability side includes a selection of mission areas that span the range of PSS capabilities, from mitigation and preparedness through to response and recovery. Time horizon and epoch/orientation identify time span and historical context, while the degree of fidelity ensures completeness and consistency. A dimension for S&T Communities allows for user-specific categorization, providing a method for accessing Chemical, Biological Radiological, Nuclear, and Explosive (CBRNE) scenarios based on type of event. Such partitioning permits the creation of a common scenario set derived from information from expert Communities of Interest for use by PSS and EM stakeholders.

## Future Plans

The PSS Planning Scenario Framework is designed to support a range of stakeholders, from policymakers to local responders. The primary benefits are the visibility and reuse of a repository of full-spectrum scenarios that have been validated by experts.

***All-Hazard Risk Assessment:*** Scenarios are a powerful tool to frame risk and invoke capabilities. This framework can serve as a guide for the selection and development of scenarios in support of the AHRA approach.

***Decision-making:*** For decision-makers, scenarios provide a common context within which to relate policy, functions, tasks and capabilities. The Scenarios are a means to objectively evaluate and prioritize between competing investments strategies.

***Training:*** For training, scenarios describe a realistic context and include a number of instances to force operators and decision makers to think and act within that context. This framework reduces the effort required for exercise development and provides a standardized scenario set to introduce expert guidance.

***Planning:*** This framework serves as a key 'enabler' to Capability Based Planning through the delivery of a clearly written and versatile set of planning scenarios. This set will be made available for use to a wide variety of subject matter experts to frame the context required to assess capability gaps along the entire time continuum for a major incident (also referred to as the "-3 to +3 timeline"). Planners are thus able to select scenarios based on risk and priority, drawing upon expert input and common planning assumptions.

***S&T Proposal Evaluation:*** Scenarios provide the driver for identifying new S&T needs and the "Petri dish" in which new science and technology is evaluated. Scenarios shape the problems that need to be addressed through investment in innovation in an attempt to improve existing capabilities. They are applied as yardsticks to evaluate improvements in capabilities both across projects and over time. The prototype database for the PSS Planning Scenario Framework will be drawn upon in the evaluation of upcoming CRTI Proposals.

# Sommaire

## Rapport final sur le cadre de création de scénarios de planification du Programme technique de sécurité publique :

**Peter Race; Doug Hales; RDDC CSS CR 2010-10**

**R & D pour la défense Canada, Centre des sciences pour la sécurité; décembre 2010.**

## Contexte

Les scénarios sont les principaux outils d'instruction de planification en matière de sécurité publique. En effet, chaque utilisateur dans le domaine de la gestion des urgences, des responsables des orientations politiques aux premiers intervenants, utilisent des scénarios sous une forme ou une autre. On utilise des scénarios pour concrétiser le concept de la planification basée sur les capacités, définir les besoins ainsi que documenter et orienter les activités d'instruction. Les scénarios permettent de préciser le problème en cause, d'évaluer les possibilités d'intervention ainsi que de déterminer les outils de mesures et d'évaluer les nouvelles technologies. Cette initiative a été mise en œuvre en guise de contribution aux études menées par le Programme technique de sécurité publique (PTSP) dans le domaine de la gestion des urgences et de l'intégration des systèmes. On a constaté qu'il est nécessaire d'avoir un cadre objectif pour aider les intervenants du secteur de la SSP dans le choix et l'utilisation commune des scénarios de planification à utiliser pour déterminer les insuffisances en capacités afin de guider l'investissement en science et technologie. Cela s'applique également aux autres secteurs du PTSP, y compris l'évaluation de tous les risques ou dangers. Le contexte de l'élaboration d'un cadre de création de scénarios de planification a par la suite été élargi à tous les domaines de capacités de la sureté et sécurité publique (SSP), à savoir : la prévention, la préparation, l'intervention et le rétablissement.

## Qu'est-ce qu'un scénario?

Les cadres offrent une structure permettant de catégoriser des questions complexes et d'organiser la pensée. Le cadre de création de scénarios de la gestion des urgences a pour but d'aider une gamme d'intervenants, à la fois à l'échelle nationale et à l'échelle locale. Il aide les utilisateurs à choisir des scénarios en fonction de leurs problèmes, objectifs, risques et calendriers particuliers. À mesure que le cadre évolue, il permettra la réutilisation de l'information et offrira un mécanisme de fixation des pratiques exemplaires et d'élaboration de normes, améliorant ainsi le rendement et l'efficacité des procédures à l'échelle locale et nationale.

Il n'y a pas de définition commune du terme *scénario*. Aux fins de ce cadre, on a distingué un scénario d'une gamme de scénarios possibles à l'avenir – les tendances futures à long terme – et de petites niches représentatives. Aux fins de la planification, les scénarios couvrent des risques ou dangers généraux prévisibles dans un proche avenir, y compris les hypothèses concernant le contexte ainsi que les capacités. Ils contiennent des hypothèses concernant le contexte (p. ex., les conditions politiques, sociales et économiques) ainsi que les capacités. Les scénarios contiennent

également une description situationnelle et un calendrier. Le produit final est un compte rendu ou un sommaire de la chronologie des événements prévus, ou une description des mesures appropriées. Le cadre comprend aussi un ensemble de scénarios qui englobent toute la gamme des capacités de sécurité publique, de l'état de préparation au rétablissement (c.-à-d. sur un horizon temporel de -3 à +3); ces scénarios globaux donnent le contexte de la planification, de l'instruction et de l'analyse.

Chaque scénario du cadre est subdivisé en catégories en fonction d'un ensemble de dimensions. Ces dimensions aident à définir et à choisir des scenarios ainsi qu'à y accéder. Les deux principaux facteurs sont les risques et les capacités. Utilisant la méthode d'évaluation de tous les risques (ETR), le cadre peut être caractérisé en fonction du stimulus ou du déclencheur, ce qui permet le choix de scénarios ayant la plus forte probabilité de se produire et comportant le plus grand risque. L'aspect *capacités* englobe une gamme de tâches qui couvrent toutes les capacités en matière de sécurité publique, de l'atténuation à l'état de préparation en passant par l'intervention et le rétablissement. L'horizon temporel et l'époque/l'orientation déterminent le laps de temps et le contexte historique, tandis que le niveau de fidélité permet l'exhaustivité et la cohérence. Une dimension pour les professionnels en S et T permet une catégorisation propre aux utilisateurs, ce qui offre une méthode pour accéder aux scénarios connexes à la technologie chimique, biologique, radiologique, nucléaire et sur les explosifs (CBRNE) en fonction du type d'événement. Cette catégorisation permet la création d'un ensemble de scénarios communs tirés des renseignements reçus des experts des communautés d'intérêt pour qu'ils soient utilisés par les intervenants du secteur de la sécurité publique et de la gestion des urgences.

## Perspectives

Le cadre de création de scénarios de planification en matière de sécurité publique vise à appuyer une gamme de parties prenantes, des décideurs politiques aux premiers intervenants locaux. Les principaux avantages sont la visibilité et la réutilisation d'un référentiel de scénarios couvrant l'ensemble du spectre ayant été validé par des experts.

***Évaluation de tous les risques :*** Les scénarios des outils puissants pour analyser les risques et faire intervenir des capacités. Ce cadre peut servir de ligne directrice pour le choix et l'élaboration de scénarios à l'appui de la méthode d'évaluation de tous les risques (ETR).

***Prise de décision :*** Pour les décideurs, les scénarios offrent un contexte commun dans lequel établir des liens entre les politiques, les fonctions, les tâches et les capacités. Les scénarios sont des moyens d'évaluer objectivement et d'établir des priorités entre des stratégies d'investissement concurrentielles.

***Instruction :*** Pour l'instruction, les scénarios décrivent un contexte réaliste et englobent un certain nombre de situations visant à forcer les exécutants et les décideurs à réfléchir et à agir dans ce contexte. Ce cadre réduit l'effort nécessaire pour l'élaboration des exercices et met en place un ensemble de scénarios normalisés offrant une orientation spécialisée.

***Planification :*** Ce cadre constitue un outil clé pour la planification basée sur les capacités grâce à l'élaboration d'un ensemble de scénarios clairs et polyvalents. Ces scénarios pourront être utilisés par une grande variété d'experts pour déterminer le contexte nécessaire pour évaluer les insuffisances en capacités pendant toute la durée d'un incident majeur (également appelé

« échéancier -3 à +3 »). Ainsi, les planificateurs sont capables de choisir des scénarios en fonction des risques et de la priorité, en tablant sur les observations des experts et les hypothèses communes de planification.

***Évaluation des soumissions en S et T :*** Les scénarios précisent les facteurs pour déterminer les nouveaux besoins en S et T ainsi que la « boîte de Petri » dans laquelle évaluer les nouvelles sciences et technologies. Les scénarios donnent forme aux problèmes devant être résolus en investissant dans l'innovation afin d'essayer d'améliorer les capacités existantes. Ils sont mis en œuvre en tant que référence commune pour évaluer les améliorations des capacités dans les projets et au fil du temps. On se basera sur la base de données prototype du cadre de création de scénarios de planification en matière de sécurité publique accessible et facile à utiliser. On se servira de la base de données prototype du cadre de création de scénarios de planifications en matière de SSP pour l'évaluation des prochaines propositions de l'IRTC.

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# Acknowledgements

The authors would like to acknowledge the enthusiastic participation and valuable contribution provided by the DRDC Centre for Security Science scientific advisory team:

Mr. Jack Pagotto;

Dr. Paul Chouinard; and

Mr. Alain Goudreau.

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# 1 Introduction

## 1.1 Purpose

Scenarios have become a prime Public Safety and Security (PSS) tool, used both to inform planning and to focus training. Every user within the PSS domain, from policymakers to first responders, employs scenarios in one form or another. Scenarios are used to contextualize and characterize the problem space, articulate objectives and establish metrics, define response requirements and rehearse procedures, analyze Concepts of Operations (CONOPs) and evaluate technology options. Scenarios can serve a critical integration role; they can also be misused through overly subjective application, biasing certain types of problems while ignoring others. Given their importance, it is imperative where possible to lend thought and apply scientific rigor to development of a scenario framework to support members of the PS and EM community and assist in selecting and defining scenarios.

Canada has made significant investment in emergency management following 911. The PSS Scenario Framework is intended to complement the existing All Hazards Risk Assessment objectives and support transition to Capability Based Planning. This examination into scenarios has been sponsored by the Public Security Technical Program (PSTP). PSTP is an evolving program administered by the Centre for Security Science (CSS) of Defence Research and Development Canada (DRDC). The mission of CSS is to collaborate with partners and deliver S&T solutions that advance the national capabilities to prepare for, prevent, respond to and recover from high-consequence public safety and security events [1]. A major driver of this study was the need to provide a means to evaluate as objectively as possible competing options and to optimize investment in S&T PSS innovations. To achieve this, the PSTP sought a PSS Scenario Planning Framework to complement a capability-based approach in which people, processes and materiel aspects are considered and integrated to produce enhanced public security "effects" or "outcomes" for Canadians. The framework will outline the Full Spectrum Scenarios required to support a maturing all-hazards approach to EM planning and investment, and will provide a common context for evaluating capability development both across domains and over time.

Although PSTP program managers are the initial target audience, the PSS Planning Scenario Framework is intended to support the needs of the wider EM community. The framework is designed to cater for ease in selecting scenarios based on unique objectives, risks and time. This is the first step in an ambitious undertaking. As the framework is further developed and matures, it is hoped it will be used to promote information sharing and offer a forum for capturing and communicating best practices, improving efficiency and effectiveness and to provide a means for understanding and improving readiness across Canada.

## 1.2 Scope

The focus of this study was on the development of a scenario framework rather than an attempt to impart a fully developed, standardized set of planning scenarios. As outlined in the Statement of Work, the work plan involved and deliverables included:

- Assimilating and analyzing available scenarios;

- Proposing a scenario framework accommodating CBRNE and Natural Disasters and the existing All-Hazards Risk Assessment time continuum;
- Developing a communication plan and tutorial linking the scenario framework to capability based planning; and
- Presenting the results at a PSTP workshop.

This report expands on these tasks, describes the methodology adopted and presents the resultant scenario framework development. Notably a separate contract was established to develop an associated prototype tool, capturing the elements of this framework as a relational database. This work fell outside the scope of this project and the results were being documented separately. As a result, the development and functionality of the tool is described only at a high level.

## 1.3 Assumptions

From the onset it was anticipated that the creation of a PSS Planning Scenario Framework would be used to facilitate efforts to develop and mature a set of standardized or recommended planning scenarios to support existing and emergent communities.[1] The scenario set may – likely will – evolve over time in response to changes in the nature of the threat and/or operating environment. Ideally the framework will be more enduring and provide the pre-requisite logic shell. Hence the desired end state for this framework is the establishment of a "living framework", to be expanded and populated by a range of users. It follows that the framework should:

- Be designed from the outset to be readily available and accessible to a distributed network of users;
- Address the full EM spectrum in both time (from preparedness and mitigation to response and recovery, or, from -3 to +3 time horizon) and function;
- Incorporate the existing and maturing all-hazards approach;
- Provide the necessary infrastructure for the selection and definition of a set of harmonized scenarios;
- Be established initially at the unclassified level, with the potential to expand to other levels as required.

## 1.4 Document Organization

This document has been divided into nine sections:

- Section 2 describes the background and purpose of the PSS Scenario Planning Framework and taxonomy;
- Section 3 describes potential users (intended audience) and applications for the framework;

[1] A draft set of PSTP sample scenarios were presented to the Science Clusters in June 2009. At the time of writing, these scenarios had not been sanctioned as the standard PSTP scenario set.

- Section 4 outlines design principles and discusses the dimensions of the scenario framework, including their origins and application;
- Section 5 summarizes the population of the framework with available scenarios and offers observations from the initial analysis;
- Section 6 proposes a scenario suite and illustrates/describes how the framework might be applied in practice;
- Section 7 tables thoughts on the Way Ahead and Recommendations;
- Section 8 includes the report's conclusions; and
- Annex A includes a sample scenario from the set developed for the PSTP Symposium.

# 2 Background

Emergency Management starts, and often ends, at the community level. Like politics emergencies are essentially "local". However, we live in an increasingly interdependent world and research has begun to address the shift to complexity and cascading effects, and to requirements for coordination, collaboration and mutual support.[2] The challenges posed by threats/hazards often overlap organizational mandates. Multiple agencies – public and private – interact, and integration and orchestration of a wide range of capabilities is required to address emergencies. This has stimulated focus on interoperability, standards and governance. Strategic coherence – translation from policy to programs – can prove a challenge, particularly given uncertainties and ambiguities. A PSTP capability-based investment process has matured and is now in place to support environment assessment and risk analysis. Concurrently Capability-Based Planning (CBP) is being adopted, in some cases, to support specification of functional requirements and to stimulate innovation. Capability-Based Planning has been described as top down and concept led. Adoption of this approach has promoted transparency and allowed vision and policy to inform the development of PSS capabilities. The end result is more effective national-level investment planning to support PS and EM requirements.

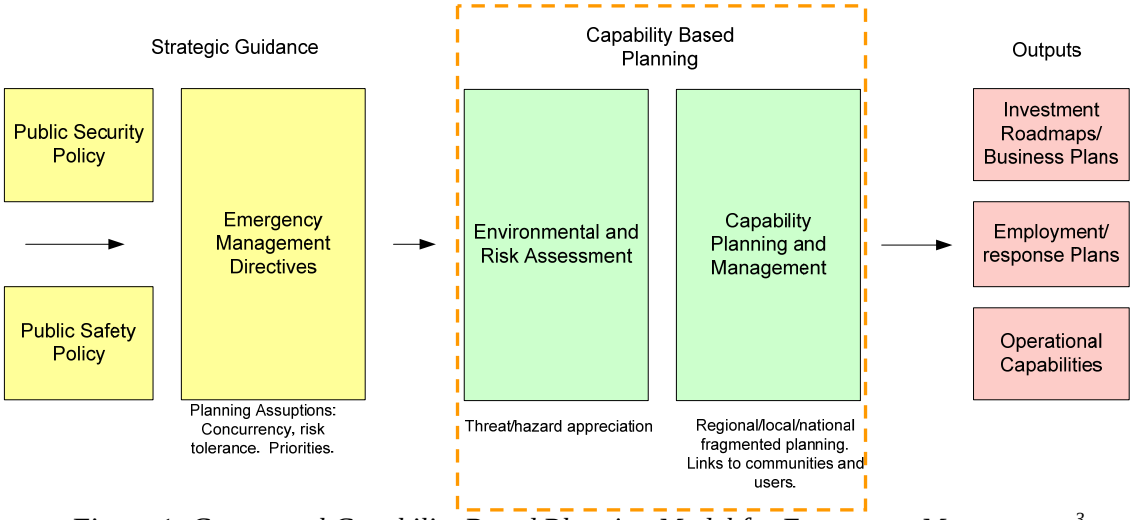


*Figure 1: Conceptual Capability Based Planning Model for Emergency Management*[3]

There are a number of ways to depict the transition from policy through programs to products. Figure 1 provides a high level depiction, with four major elements: Strategic Guidance;

[2] Frequent reference is made to the growing complexity and continuing uncertainty governing security operations. Interdependence infers inclusion and the increasing number of factors and diversity of participants and perceptions to be considered – this renders the system **complicated** (i.e., characterized by having many moving parts). **Complex** endeavours involve non predictive behavioural changes: patterns may be discernable but small differences in initial conditions and/or minor perturbations may produce significant divergent outcomes. For more information, see Alberts & Hayes, *Power to the Edge*, DoD CCRP, 2003.

[3] Adapted from DND Capability-Based Planning model.

Capability-Based Planning (CBP); and Outputs distinguished. Each is described in more detail below.

## 2.1 Strategic Guidance

Typically national interests are enduring but strategy evolves, both driven and reflective of history, cultural values and societal preferences. Although attention is often focused on periodic reviews and White Papers, policy is often determined through day-to-day interpretation and application of strategy. From this perspective, planning can be viewed as a complement direction, an investigation into policy implementation.

At all levels, national to local, scenarios provide a means to discuss and guide investment decisions relating to policy implementation. Planning is bound by policy assumptions. Typically these include guidance on levels of ambition and risk tolerance; e.g. concurrency assumptions may be expressed in terms of scenarios and preparation and/or response standards related to scenarios. Examples include specified capacity to respond to simultaneous calls on resources, hospital wait times, target response windows and acceptable capability gaps. Scenarios provide a common contextual setting to foster dialogue and provide strategic direction. Notably the UK has an annual process to review defence planning assumptions and provide direction to planning staffs [2].

## 2.2 Environmental and Risk Assessment

Emergency Management in Canada is driven primarily by a risk-based approach. [13] Scenarios are used to describe an event, to provide a representative picture and facilitate risk identification and articulation. Through an understanding of risk (the probabilistic and consequential outcomes of events), it is hoped that greater resiliency through preparedness and more effective response and recovery can be realized. Risk can be thought of as "the presence of a hazard or threat that is related to vulnerability". [13] In keeping with traditional risk analysis practice, risk assessment involves consideration of cause, probability (likelihood of occurrence) and impact (severity of consequences). [13] Unfortunately vulnerability, threat and consequence are interrelated and cannot be assessed in isolation e.g. consequences shape adversaries' choice of targets. [14] It follows that an environmental assessment and risk analysis reflect a contextual setting and subjective judgement by Subject Matter Experts (SME). There are a large number of stakeholders involved in risk management and risk mitigation necessitates mechanisms for collaboration and coordination of efforts. Effective risk management requires integration of both top down and bottom up perspectives i.e. input from subject matter expertise, coordinated at the national level and engagement of local-level planners and responders. A common planning scenario framework that caters to tactical responsibility informed by strategic expertise would enhance the benefits of risk assessment. In this case, scenarios provide a means not only to bridge the gap between "classroom training in the abstract and practical training during real disasters", [4] but also the gap between community-level training priorities and expert advice from communities of practice. In the model presented the environmental assessment and risk analysis help to provide structure, disciplining imagination, bounding the scope and focusing planning efforts.

## 2.3 Capability Based Planning

Capability-Based Planning was introduced in the 1990s in the defence community as an alternative to Cold War threat-based planning. [3] The shortfalls of threat-based planning were known and included:

- Threat-based planning is susceptible to deception and planners can mischaracterize and/or underestimate risks;
- Planners traditionally tend to "mirror image" threats or hazard where little hard intelligence is available;
- Large bureaucracies tend towards "group think"; and
- Resource constraints tend to focus time and money on big ticket systems and replacement for existing systems (i.e. platforms).

The fall of the Berlin Wall and demise of the Warsaw Pact ushered in a new era of ambiguity and volatility. CBP has been aptly described as "planning, under uncertainty, to provide capabilities suitable for a wide range of modern-day challenges and circumstances". [3] It embraces functional analysis of operational requirements necessary to respond to a broad range of circumstances and challenges.[4] It is intended to be concept-led and top-down driven, to acknowledge interdependencies inculcate holistic (system-of-systems) thinking and foster innovation, and to challenge and supplant the existing culture. This implied a step change from previous organizational focus on platform replacement and a revision of process and governance.

While the merits of CBP are recognized in the abstract, Other Government Departments and the Emergency Management community lack the dedicated staff resources that DND has. A streamlined CBP model is required to support Public Safety in practice; one that allows stakeholders to appreciate both enterprise and individual perspectives. One of the major benefits CBP offers is increased transparency and coherence i.e. a tool for defining strategy, for communicating goals and for aligning initiatives.

The DRDC CSS model for CBP [Figure 2] couples risk and capability to support an all-hazards approach to capability development and management. It makes use of many existing tool and models in current use, such as the US Department of Homeland Security (DHS) Target Capabilities List (TCL) and National Incident Management System (NIMS), evolving and placing them within the Canadian context.

[4] CBP has been construed to 1) include requirements definition, options analysis and acquisition/capability generation and 2) describe the front-end goal characterization. Confusion can exist because the two interpretations are often used interchangeably.

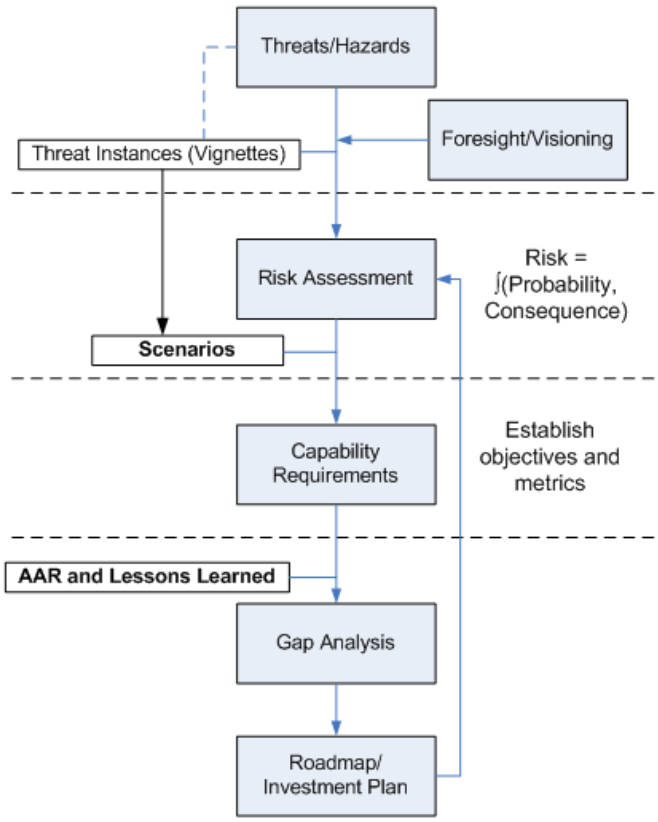


*Figure 2: CSS Approach to Capability Based Planning*

Through a Consolidated Risk Assessment (CRA) process, the identification of critical threats and hazards creates a spectrum of candidate threat instances. Risk assessment follows and prioritized risk incidents are selected for elaboration and analysis. The resultant scenarios are a result of expert insight and represent a viable illustration of the spectrum of existing and emergent threats. They provide the backdrop for determining if current capabilities (people, processes and technology) are adequate – for characterizing and prioritizing gaps. Scenarios can also be used to evaluate options and, hence, indirectly inform investment plans.

## 2.4 Outputs

As depicted in Figure 1 CBP generates several key outputs. The first, alluded to above, relates to investment planning. Although programmatics factor in, the gap identification and comparative analyses can serve to help align and direct business plans. A second deliverable relates to contingency planning. Scenarios can be used to supply context and focus discussion. Plans will likely not survive contact with the enemy but planning as an activity and the relationships and understandings which accrue as a result have considerable value. Further the response plans developed provide a departure point and an important means for knowledge elicitation and capture. Finally, and most importantly, CBP must support capability generation and maintenance. The operational end result is still ultimately achieved at the local level. Through a better understanding of capability gaps, planning considerations and interdependencies, planners and operators should be better equipped and prepared to perform the necessary PSS functions.

Recognized areas for improvement are met by improving PSS capabilities through organizational adjustments, new processes and technologies, as well as more effective planning, training and qualifications.

## 2.5 Scenario Taxonomy

Although they have much in common, there is significant variation in the definition and application of the term "scenario". Under one guise or another, scenarios are employed by a variety of stakeholders to serve distinct (and diverse) purposes. To provide better guidance to the use of planning scenarios, a shared understanding of terms and common taxonomy is vital. A simple comparative table [Table 1] has been created to illustrate community usage and merge and align the terminology.

| User/Community | Highest Order (Long-term Strategic View) | Second Order (Current to near-future, Operational View) | Lowest Order (Real-time, Tactical View) |
|---|---|---|---|
| Business Planning [6] | Planning Scenario/Alternate Future | Factor/Driver/Trend[5] | |
| Risk Assessment [16] | - | Scenario Vignette | Risk Descriptor; threat instance |
| Emergency Management Exercise Design [18] | - | Scenario | Problem Statement |
| PSS Planning Scenario Framework | Alternate Future | Scenario/Full-Spectrum Scenario | Vignette |

*Table 1: Scenario Taxonomy Spectrum*

While all applications are valid in their own right, intent and functions vary. For example, those terms applied for long-term strategic planning are designed to provide a high-level description of context, and provide fewer of the details necessary for operational planning: "High level

[5] These terms do not map directly to "scenario", as a scenario is composed of several factors/drivers/trends, such as demographics and environment.

descriptions are good for planning, scoping, bounding and segmenting but not for implementing" [7]. Rather than introducing a new taxonomy, a taxonomy drawn from existing sources has been developed to promote common understanding and usage. The four orders of decomposition, "Scenario", "Vignette", "Alternate Future" and "Case Studies" have been selected to distinguish the different levels of fidelity and timeframes, as illustrated in Figure 3.

### 2.5.1 Alternate Futures

From a strategic planning perspective, alternate futures were developed for identifying long-term trends for business transformation. Royal Dutch Shell is renowned for their use of alternate futures in conducting strategic business planning and is a great proponent of their value:

Scenarios help us to understand today better by imagining tomorrow, increasing the breadth of vision and enabling us to spot change earlier… Effective future thinking brings a reduction in the level of "crisis management" and improves management capability, particularly change management… Scenarios provide an effective mechanism for assessing existing strategies and plans, and developing and assessing options.[6]

The value of alternate futures comes both from the process and the product. The identification of critical drivers helps to develop contrasting views of distinct future "worlds". The different interpretations of which are the most fundamental drivers when "imagining tomorrow" can differ based on stakeholder. By identifying and selecting such drivers and trends as a group, a more cohesive business strategy begins to evolve. The end product, a set of strategic alternate futures, supports exploratory analysis and provides insights on macro level uncertainties, dynamics shaping the future and strategic, long term indicators.

In contrast to alternate futures, scenario-based historical incidents – case studies – are subject to interpretation but have the advantage of being grounded. Valuable lessons learned can be extracted from an objective analysis of real world data and historic experience. By way of example, in the Emergency Management realm Hurricane Katrina provided a wealth of knowledge. From a planning perspective, case studies have significant impact in the extrapolation of past events for future trends: "...the method involves taking the physical determinants of a given impact of the past, which is considered appropriate as a guide to what will happen in the future (perhaps as a worst case) and applying them to modern conditions, particularly regarding the human environment and the population at risk". As a result, scenarios are often framed by the author or organization's experiences. While perhaps a stretch to suggest those who ignore the past are condemned to relive it, there is no doubt that case studies can prove relevant.

While an extrapolation based on case studies is valuable, alternate futures provide a tool to escape the cognitive constraints of straight projections of the status quo: "…human beings tend to frame their thoughts about the future in terms of continuities and extrapolations from the present and occasionally the past." [3] Such projections often overlook strategic shocks, or "black swans". These are unpredictable events that dramatically change the PSS operating environment. [8] The attack on the World Trade Centre on September 11, 2001 was such a shock, leading to the Global War on Terrorism and increased emphasis on the need for effective coordinated multi-agency response to complex events. While alternate futures may not be able to capture all black swans, a capability-based approach helps mitigate some degree of the risk posed by an uncertain future.

### 2.5.2 Scenarios

More than anything scenarios provide the means to capture assumptions about context (e.g. political, social and economic conditions), challenges and capabilities. They can be used to develop a shared appreciation and to highlight differences of view. These initial "boundary conditions" frame objectives, define the problem scope and provide a departure point for exploration [4]. A "baseline" scenario can be used to capture the roles, relationships and resourcing associated with routine activities. More typically a possible (if not probable) generic threat or hazard provides the driver and scenarios are used to illustrate the danger and orient reaction. Characteristically, scenarios outline circumstances and suggest a timeline inviting dialogue. The final product is an account or synopsis of a projected sequence of events, or description of a course of action. As explained in the following section, each scenario can contain both variants and multiple vignettes.

### 2.5.3 Vignettes

In addition to providing the contextual backdrop, planning scenarios typically describe a chain of events, akin to the Master Events List (MEL) used in designing live exercises. Individual scenario elements, or vignettes, that are often very specific, including a level of detail necessary for situating the operator to elicit a specific reaction or consideration for planning, training and analysis can be included.

The term vignette, meaning "little vine", is derived from theatre script and poetry. Vignettes are short, impressionistic compositions or scenes that focus on one moment and are not necessarily linked sequentially into plot development. Within a scenario, this can be a secondary incident, such as a fire caused by an earthquake. Such vignettes may be incomplete or fragmentary, acting as a snapshot within the overall scenario context. Vignettes are typically a short sketch describing an incident used to illuminate or bring insight to a particular issue or element.

This framework focuses on the scenario level, while addressing vignettes as components or variations on a scenario. Each scenario contains at least one vignette, and vignettes can be attached to different scenarios.

### 2.5.4 Timeframe/Epoch

As illustrated at Figure 3, there are two distinct time axes. The first is a scenario placement referenced to current day. Scenarios can be set in the future or past, characterized as epoch orientation. The second alluded to above, is associated with the string of events within a scenario.

Typically the focus of Capability-Based Planning is on projection and risk management; planning scenarios are situated in the near future so as to inform the next generation recruitment and/or equipment acquisition. Planners have been charged with being preoccupied with past wars/incidents. Scenarios can be used to help anticipate and pre-empt challenges; based on trends or drivers which characterize past events. Balancing past experience and future trends, it is

proposed that PSTP scenario selection be based on risk assessment rooted in the near future. For the operational community this equates to between the present and 6 months to two to five years into the future. However, the framework is well-situated to address the range of timeframes to support strategic planning and investment as well as current training initiatives.

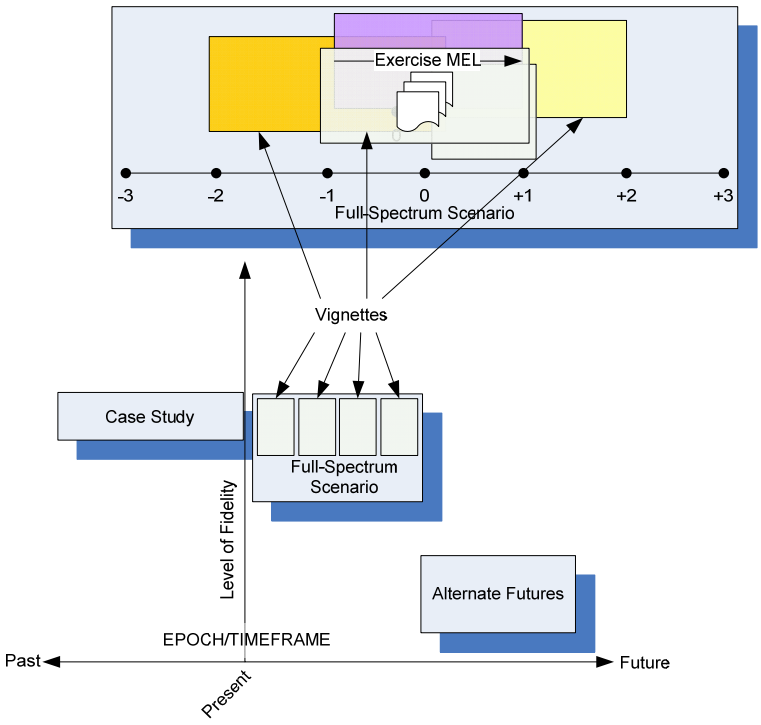


*Figure 3: Scenario Taxonomy*

### 2.5.5 Full Spectrum Scenarios

The second time axis exists within a scenario. The term "Full-Spectrum Scenario" has been introduced by the CSS to promote an inclusive consideration of security measures. A "full-spectrum scenario" spans time within a scenario and is designed to incorporate an ability to reflect on all four phases/functions (prevention/mitigation, preparedness, response and recovery), and hence can be applied across a time horizon extending from years before an incident to years after an incident (-3 to +3 as explained in Section 4.1.5) [9]. In practice the threat instances which originate from the Risk Assessment process serve as the driving incident providing the stimulus and focus. Many scenarios start from that point and develop a corresponding "road to war" furnishing a contextual chain of events and explanation. It is well worth noting in passing that "back casting" is an established methodology for working back and exploring potential prevention and preparedness measures.

Within the context of the planning scenario framework, vignettes typically exist within a specific time horizon, such as on-scene response (+1). A full-spectrum scenario is designed to contain at least one vignette per time horizon.

# 3 Scenario Users and Applications

Capability-Based Planning is intended to promote a holistic perspective, transcend organizational biases and encourage an interdisciplinary analysis i.e. to support formalized integrated planning and decision-making in complex systems. Scenarios are one of the prime tools available to assist such diverse PSS stakeholders. Hence, this framework, in supporting a capability-based approach, aims to create a scenario framework that can support a diverse set of users: decision-makers; planners; innovators; trainers and evaluators across the EM spectrum. It is hoped that the common set of scenarios that evolves from this framework will foster alignment and facilitate the development and systemic evaluation of PSS capabilities.

## 3.1 Scenarios for PS and EM Capability Development

A major goal for PSTP is to optimize investment in S&T and to reduce risk and costs. This will necessitate the development and institutionalization of effective and efficient processes. Each jurisdiction and agency will have its own set of capabilities, which are applied to achieve desired outcomes and are evaluated based on target levels of performance. A key element of this process requires the use of "planning scenarios". These planning scenarios are selected as the conditions under which capabilities are evaluated. For PSTP, these scenarios will be used to assist with the risk assessments and the related gap studies that are required before solution options can be formulated.

This project aims to support PSTP efforts at applying CBP for PS and EM through the development of a common framework for planning scenarios. This framework will serve as a key 'enabler' to Capability Based Planning through the delivery of a clearly written and versatile set of planning scenarios. This set will be made available for use to a wide variety of subject matter experts to frame the context required to assess capability gaps along the entire time continuum for a major incident (also referred to as the "-3 to +3 timeline").

### 3.1.1 Decision-Makers (e.g. Capability Generators/Managers)

Scenarios provide a common representative context to relate policy, mission areas, capabilities, functions and tasks, mapped to a relevant environment. They are a means to evaluate objectively and prioritize between competing investments strategies.

For context, the mapping of policy is often done within the context of scenarios. For example, the Department of National Defence (DND) employs planning scenarios which support concept development and foster a shared concept of employment for the Canadian Forces. As with the PSS domain, past events and operations are characterized within a scenario set to examine concurrency demands and assist decision-making (e.g. the policymakers could then make use of analysis driven by a probabilistic extrapolation of future threats and hazards based on the scenarios).

In short, scenarios support decision-makers in planning under uncertainty, both in terms of longer term capability investment and short-term contingency planning.

### 3.1.2 Scenarios for PSS Planning, Training and Employment

The requirement to focus efforts on operations often reduces the available resources to conduct planning and training. Scenario development is a critical element of these activities, as it defines the context by which preparedness is assessed. Facing such constraints, the current application of scenarios often tends to be ad-hoc. With each agency and jurisdiction creating their own scenarios, ensuring that "they see what they think they need to see" in a scenario, since there is no repository to draw upon and no standardized set of scenarios to provide expert guidance. Given the desire to apply rigorous, traceable planning process, there is a significant requirement and a strong desire to see the development of a common PSS Planning Scenario Framework and accessible scenario set so that much of this 'subjectivity' of scenario and vignette selection is reduced as much as possible.

*Figure 4: Scenario Application for Training*

For training, scenarios describe a realistic context and include a number of instances to force operators and decision makers to think and act within that context. For the example of the CRTI-0058 Project, the simulation-based scenario that was demonstrated allowed trainers to capture simulation results for analysis against a set of metrics.[6] This model of executing scenarios for training also lends itself to CBP through the relation of common scenarios to metrics for capability evaluation and improvement.

### 3.1.3 Scenario Support to S&T Communities

Within S&T communities, scenarios provide the driver for identifying new S&T needs and the "Petri dish" in which new science and technology is evaluated. Scenarios shape the problems that need to be addressed through investment in innovation in an attempt to improve existing capabilities in managing existing threats as well as providing new capabilities to deal with future threats and hazards. In addition, scenarios can be applied as yardsticks to evaluate improvements

[6] The Chemical, Biological, Radiological, and Nuclear Research Technology Initiative (CRTI) Memorandum of Understanding (MOU) established CRTI Project # 05-0058TD: "Unified Interoperability Solution set to Support Concept of Operations Framework Development", to support increased Municipal-Provincial-Federal collaboration to CBRN response. The technology developed under this project was delivered to the Justice Institute of British Columbia (JIBC) to support future training of first responders. For more information, see DeJager, C., Krga, P., Race, P. CRTI 05-0058TD Final Report DRAFT. CAE Professional Services, 2009.

in capabilities both across projects and over time. The S&T community has to consider both current employment and future capability development in determining an investment strategy.

# 4 Creation of a PSS Scenario Framework

A framework can be viewed as a schema designed to provide a structure for addressing complex issues. Equally it can be described as the classification of descriptive representations relevant to the enterprise – in this case characterizing scenarios relating to public security. These illustrative interpretations can be made explicit and stored in a database to facilitate analysis. Significantly the framework is intentionally independent of application and does not prescribe use, methodology or process. There are two properties of a framework that are particularly germane to this project. First, a framework should allow for aggregation and simplification of multiple components, dimensions or elements. The PSS Planning Scenario Framework developed for this project makes use of this function for sorting and filtering, displaying, searching, analyzing and selecting scenarios for a number of uses. A second important property of a framework stem from its origin. The term frame, derived from the word "from", means "to make progress". It should serve as a foundation for increased sharing, reuse and, eventually, standardization. The bottom line – a framework must provide a useful way to organize information. The PSTP Scenario Framework is designed to be expanded and extended to capture new information and scenarios, and grow to meet new users and new requirements.

A set of explicit principles were developed:

- The set should cover the EM engagement spectrum i.e. facilitate establishing the range of requirements from prevention and mitigation to recovery.
- Should cover all classes of users, and built for continued expansion through ready access and evolution. This should include established communities such as the CBRNE Communities of Practice and Risk Managers.
- Categorization should allow for concurrency analysis to help appreciate demand and establish capacity requirements. This is a categorization and visualization element that is critical to making informed investment decisions.

## 4.1 Identification of Framework Dimensions

Past analytical practice has shown that it is often necessary to decompose complex problems into more digestible chunks. Care must be taken in determining how to frame and dissect the problem i.e. how to identify and typify key parameters. The dimensions chosen, ideally orthogonal, should define and represent the different aspects. This is as much art as science and there is no clear right or wrong solution; however, some principles have been identified. For example, classification/grouping criteria should address the following elements [20]:

- Similarity (like characteristics);
- Partitioning (least interfaces);
- Aggregation ((hierarchical structure) ; and
- Stability (established components).

The final test Vencel, Cook and Matthews suggests is Form, Fit & Function. While the number and name of partitioning principles may differ, these capture the fundamental principles and informed selection of the Dimensions of the PSTP Framework.

The underlying concept for all of these criteria is to ensure that the most optimal dimensions are selected, avoiding redundancy wherever possible. Additional selection criteria include form, fit & function. These criteria are designed to ensure dimensions relate to organizational structure, without prescribing it. The dimensions include key elements of the environment that must be characterized by a scenario, including policy/governance, social, physical and environmental elements.

While the initial set of dimensions was specifically created to meet user requirements, it is anticipated that the framework will be extended and expanded to include other dimensions to meet the needs of additional stakeholders. For example, the S&T communities may expand to include other communities of practice (e.g. cyber and psychosocial communities), and extended to include additional dimensions related to community-specific scenario dimensions.

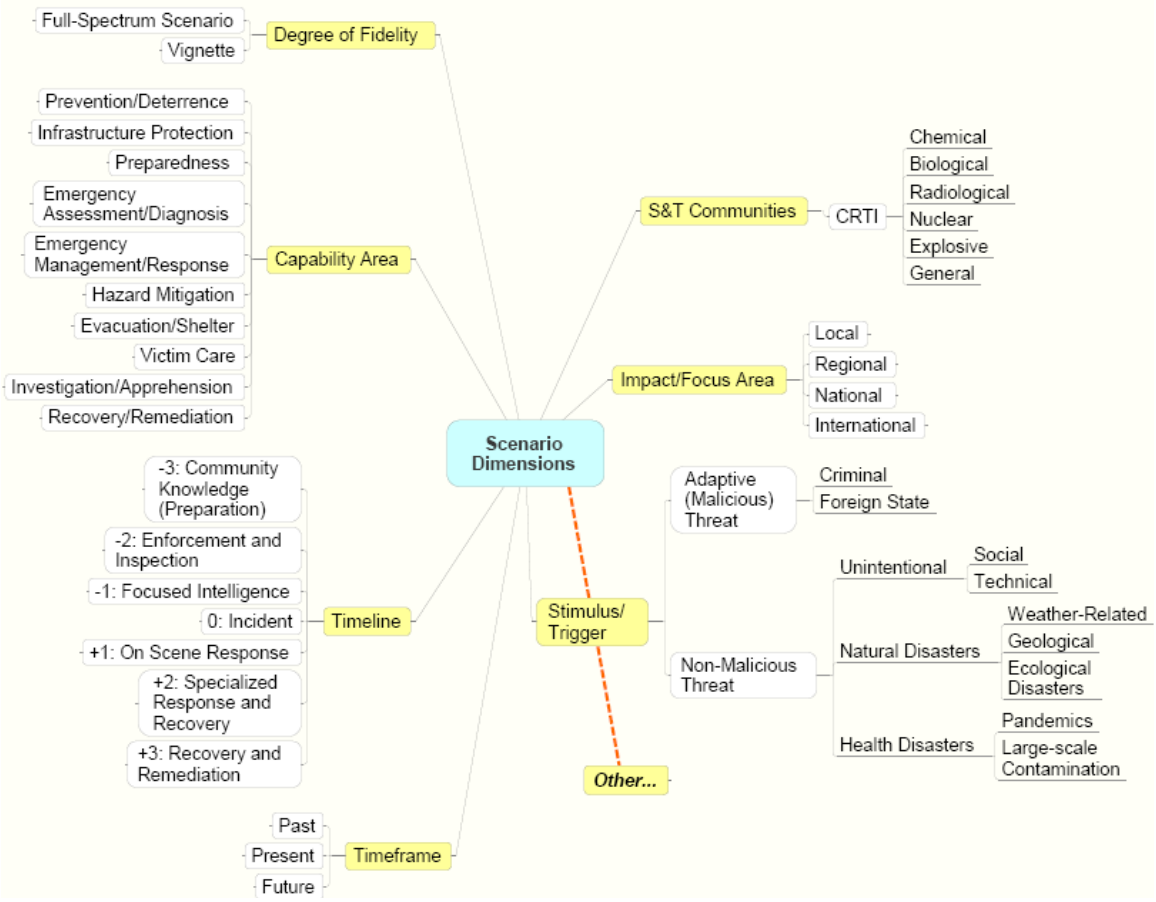


*Figure 5: PSS Planning Scenario Framework Dimensions*

The identification of this project's criteria was driven largely by user requirement. As discussed in Section 3, the potential end-users of this framework often have specific requirements (i.e. S&T

community) that drive their selection of a scenario. Other dimensions are common to multiple users. By choosing both common and user-specific dimensions, the framework meets the principle of applicability without violating the criteria of form, fit & function. In addition, the criteria help ensure the selection of a scenario involves a degree of rigour. For example, the time horizon of -3 to +3 is valuable for the evaluation of S&T proposals along the EM spectrum, and also guides planners in considering the full range of response considerations when developing an emergency response plan.

There is a degree of overlap across dimensions. For example, many mission areas occur within a specific portion of the timeline. However, the overlap does not impede the value of the framework and provides additional benefit to a greater number of users.

### 4.1.1 Dimension: S&T Community (C,B,R,N,E, Other)

One major focus for the public safety and security science and technology (S&T) is on threats and risks posed by chemical, biological, radiological, nuclear and explosive (CBRNE) substances/agents. To ensure that the PSS Scenario Framework aligns with PSTP policy, it was important to ensure that scenarios were mapped against the full spectrum of CBRNE threats. By doing so, SME can select scenarios that impact upon their area of expertise, and capability managers can ensure the existing set adequately addresses the full spectrum of CBRNE threats.

The users of this framework will primarily be from the CBRNE Research and Technology Initiative (CRTI), which engages members of the federal S&T community to focus on the joint needs of scientific labs and the operational community for addressing potential CBRNE terrorist attacks. [12] CRTI is broken into Science Clusters that inform the framework. It is along these clusters that CBRNE capabilities are developed, and so the framework used them as its criteria:

> Chemical: The main goals of the Chemical Cluster are to improve analytical approaches to the detection of hoaxes, identify lead laboratories for all chemicals on the priority substances list, and address gaps in the lead laboratories' capabilities for analyzing chemicals on the list; improve integration of data and information management systems for operational needs; develop improved capabilities for field detection of chemicals on the list; and improve mobile analytical capabilities to provide direct support to responders.
>
> Biological: This Cluster strives to provide science and technology (S&T) advice and further enhance capabilities for the protection and security of Canadians against bioterrorist threats.
>
> Radiological-Nuclear: The Radiological-Nuclear (RN) Cluster focuses on enhancing RN response preparedness through basic research and training, exercises, and activities addressing the integration of decision support tools, radiological contamination, and sustained capabilities across all government levels. For the purposes of developing scenario criteria, the radiological and nuclear aspects of the cluster have been separated.

Explosive: Newly established in 2007, the Explosives Cluster focuses on scenarios where explosives are the threat agent, as well as providing advice when explosives are used as a dispersal device for CBRN agents.

There additional clusters, including the Forensics, Psycho-Social Clusters, which are omitted from the framework as scientific clusters. These clusters cover a broad spectrum of threats and hazards, and thus fall outside the scope of this dimension.

Natural Hazard: In order to support both an all-hazards approach to emergency management and to allow completeness in criteria, the "Natural Hazard" criterion was added to this dimension. Through the population of the framework, those scenarios falling outside the CBRNE Scientific Clusters were all natural events. As a result, this sixth criterion was created.

The initial focus is on the CBRNE Clusters/Communities of Practice (CoP), with the intention to expand to future areas as the framework develops. With new threats and areas of focus emerging, the desire to evaluate scenarios based on other specific threats (i.e. cyber) or impacts (i.e. psychosocial) will require additional variables within this dimension. Engagement with these CoPs and inclusion within the framework through future initiatives would be of value.

### 4.1.2 Stimulus/Trigger

Risk constitutes one of the most important dimensions of the framework. A risk-based approach informs the interdependent functions of emergency management in Canada. A risk-based approach is based on informed choices of alternate unwanted outcomes. In other words, communities make risk reduction choices based on the acceptability of consequences and the frequency of hazards. [13] This approach emphasizes the importance of assessing vulnerability to all hazards at the outset to determine the optimal balance and integration of functions to address vulnerabilities and risks. [13] As mentioned in Public Safety Canada's "An Emergency Management Framework for Canada", the presence of a hazard or a threat that is related to vulnerability constitutes a risk. Risk management practices facilitate improved decision-making by clarifying the dimensions of risk, including its causes, likelihood of occurrence and possible severity of consequences.

A risk-based approach is already in place in Canada. In British Columbia, the Hazard, Risk and Vulnerability Assessment allows a community to make risk-based choices to address vulnerabilities, mitigate hazards and prepare for response to and recovery from hazard events. [15] Selection of planning scenarios thus reflects an awareness of potential problems when assessing available capabilities.

For the risk dimension of the framework, this project adopted the Risk Event Taxonomy, developed as a part of the CSS All-Hazards Risk Assessment (AHRA) project. [19] The elements of the taxonomy are outlined in Figure 6.

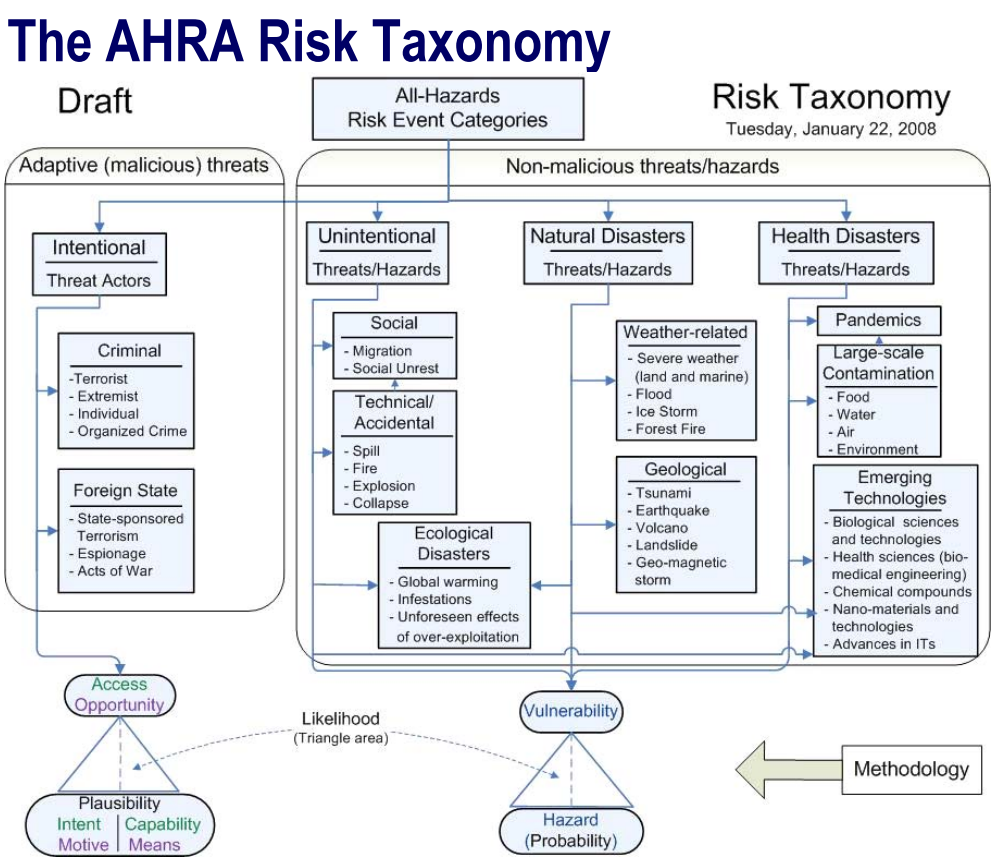


*Figure 6: AHRA Risk Event Taxonomy*

While there are four levels in this taxonomy, the framework only decomposes to three:

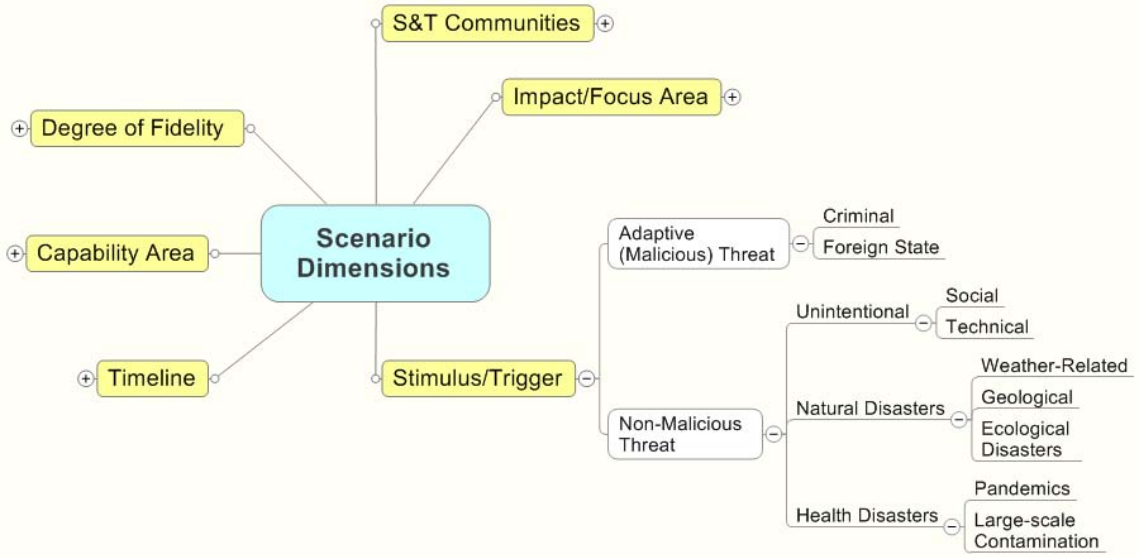


*Figure 7: Framework Dimension - Stimulus/Trigger*

### 4.1.3 Fidelity

Any attempt to characterize scenarios and develop a framework must address the question of abstraction. Scenarios set in a largely theoretical context can be used to avoid pre-occupation with geographical constraints and current concerns. On the other hand, often, more effort is required to create a synthetic world environment and authenticity may be lost. In short, abstraction allows for robustness and fewer revisions but comes at a cost e.g. perceptions of relevance. Fidelity generally refers to how faithful - true to the real world - a scenario is. Every scenario is a simplification of sorts but should aim to be as accurate and valid as possible without becoming overly complex and risking losing sight of the forest. It follows that, finally, scenarios must incorporate appropriate resolution. That is, the degree of precision included should relate to the question posed and outcome desired. In short, the units of measurement should be tailored to the objective. Abstraction, Fidelity and Resolution are associated concepts and have, for the purposes of the scenario framework, been grouped.

The scenarios reviewed varied in both focus and level of detail. Some are skeletal (e.g. there is nothing but a couple of descriptive sentences), while others have an hour-by-hour decomposition of discrete events. Some include alternative vignettes, while others are only designed to provide a single, unifying context. Those that are too highly focused on a particular incident and provide little context for operational planning are categorized as vignettes. For the purposes of this framework, the Fidelity dimension allows for a binary differentiation between scenarios and vignettes. This seems sufficient as each serves a unique purpose (see Section 2.5). For S&T proposal evaluation, full-spectrum scenarios are only of relevance.

The Fidelity dimension is intended to be more than a reflection of resolution, or level of detail, in the scenarios or vignettes. A certain level of quality control has been conducted in the initial population of the framework, such that those scenarios which did not provide adequate detail for the user were excluded.

### 4.1.4 Impact/Focus Area (Local/Municipal, Regional/Provincial, National/Federal, International)

Emergency response, as mentioned earlier, begins at the local level. However, a significant portion of more complex or larger scale scenarios require the involvement of resources, departments and agencies at the provincial/regional, federal/national and international levels. This is of relevance when planning, exercising or supporting through S&T any improvement, any improvement in interoperability or definition of mandates, roles and responsibilities. As a result, the impact/focus area dimension shown in Figure 8 provides criteria for the four levels of PSS stakeholder engagement.

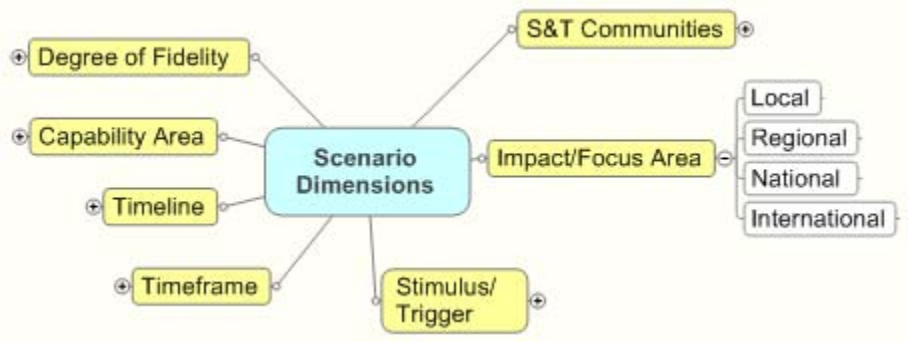


*Figure 8: Scenario Dimension - Impact/Focus Area*

### 4.1.5 Time Horizon (i.e. "-3 to +3")

Emergency response and management occurs beyond the time of incident. After the initial response, there is often a residual requirement for additional, specialized response as well as recovery activities. Further, the consideration of readiness factors (prediction, prevention, mitigation and deterrence) is the primary focus in developing PSS S&T solutions. [9]

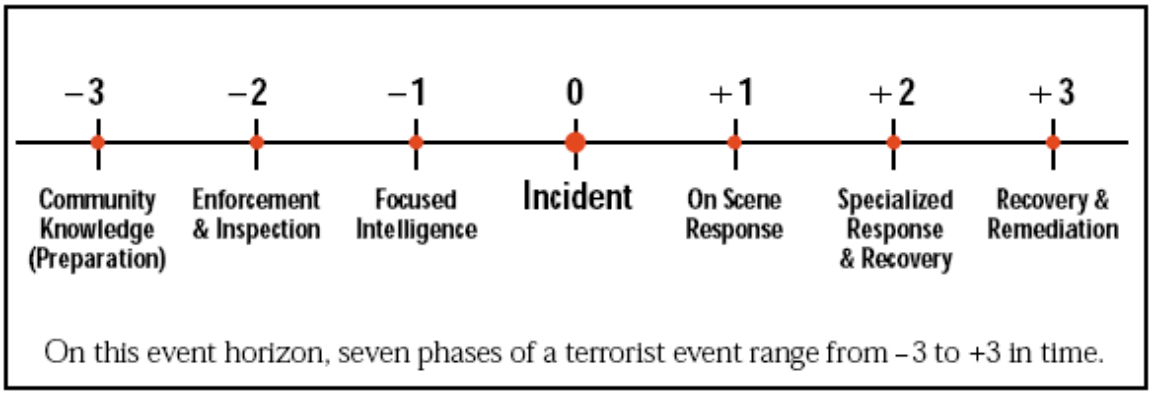


*Figure 9: Scenario Dimension - Time Horizon*

While Figure 9 refers specifically to terrorist scenarios, the same time horizon applies to all hazards. Natural disasters, while not always predictable or capable of mitigation, still involve phases of preparation and monitoring, as well as recovery. As such, the time horizon dimension is applicable for all scenarios.[7]

**-3: Community Knowledge.** Preparation at this stage consists of activities that gather all available knowledge and experience to anticipate and understand the threat, its components and mechanisms for prevention or mitigation. It involves education and participation of the wider community, such as in community policing and public health and wellbeing.

[7] The definitions of these phases of the time horizon are modified from Sheldon Dickie, Cam Boulet and Susan McIntyre, "From Response to Prevention", *Frontline Security*, Issue 3 (2006).

**-2: Enforcement and Inspection.** The next phase is proactive. It involves taking steps to stop an event from occurring and to protect either life or infrastructure from being effected from a future incident.

**-1: Focused Intelligence.** This stage includes applying skills or activities just prior to a planned terrorist event which could prevent or reduce the impact of the attack. Activities require an alert mechanism and the specialized knowledge to base appropriate decision-making and actions.

**0: Incident.** "Ground Zero" signifies the terrorist event as it is occurring. This could involve the first transmission of a bio-terrorist incident, the explosion of a radiological dispersal device (dirty bomb), or the release of a chemical agent.

**+1: On Scene Response.** Immediately after a terrorist attack, the first responders will most likely be non-specialized personnel without training in CBRN response. They would probably consist of regular fire, police and ambulance staff. They could also be veterinarians, food inspectors, or front-line hospital staff. It might not suspect or know how to identify the weapons or effects without receiving a pre-warning.

**+2: Specialized Response and Recovery.** By +2 on the *Horizon*, it will have become obvious that the situation is of a CBRN nature and requires specialized assistance. Specialized responders will be called in, initially at the local level and then at provincial and federal levels. Very specialized equipment and therapies will be required to respond to unfolding events. In this stage, recovery operations are initiated to ensure that lives and infrastructure are protected and secured.

**+3: Recovery and Remediation.** In the final stage, recovery continues but shifts to remediation which is to return the subject of the attack to pre-attack status, or as near as possible.

### 4.1.6 Timeframe

The scenario timeframe is described in detail in Section 2.5.3, describing the difference between a scenario that exists in the past (i.e. case study), present or future. Given that scenario users need to be able to differentiate if a given scenario is being used to analyze past events or evaluate current or future capabilities, a timeframe dimension was included within the framework.

### 4.1.7 Capability Area

Below are the capability areas, designed to associate those capabilities that would be invoked from a given scenario. The capability areas below have been adopted from the US DHS mission areas outlined as a part of their national planning scenarios. [17] This set differs from the DHS Target Capability List (TCL), which includes a set of 37 capabilities mapped against the EM functions (i.e. prevention through to recovery). The capability areas included in the framework help to categorize scenarios based on the activities or tasks invoked for the scenario incident(s), and are thus separate from the operational context. It is anticipated that these capability areas will be modified or replaced as a Canadian-specific set of capabilities is defined. The capability areas are:

- ***Prevention/Deterrence*** **–** The ability to detect, prevent, preempt, and deter terrorist attacks and other man-made emergencies

- ***Infrastructure Protection –*** The ability to protect critical infrastructure from all threats and hazards
- ***Preparedness –*** The ability to plan, organize, equip, train, and exercise homeland security personnel to perform their assigned missions to nationally accepted standards – this mission area includes public education and awareness
- ***Emergency Assessment/Diagnosis –*** The ability to achieve and maintain a common operating picture, including the ability to detect an incident, determine its impact, determine its likely evolution and course, classify the incident, and make government notifications
- ***Emergency Management/Response –*** The ability to direct, control, and coordinate a response; manage resources; and provide emergency public information – this outcome includes direction and control through the Incident Command System (ICS), Multiagency Coordination Systems, and Public Information Systems
- ***Hazard Mitigation –*** The ability to control, collect, and contain a hazard, lesson its effects, and conduct environmental monitoring – mitigation efforts may be implemented before, during, or after an incident
- ***Evacuation/Shelter –*** The ability to provide initial warnings to the population at large and at risk; notify people to shelter-in-place or evacuate; provide evacuation and shelter support; and manage traffic flow and ingress and egress to and from the affected area
- ***Victim Care –*** The ability to treat victims at the scene; transport patients; treat patients at a medical treatment facility; track patients; handle, track, and secure human remains; provide tracking and security of patients' possessions and evidence; and manage the worried well
- ***Investigation/Apprehension –*** The ability to investigate the cause and source of the incident and identify, apprehend, and prosecute those responsible for terrorist attacks and other manmade emergencies
- ***Recovery/Remediation –*** The ability to restore essential services, businesses, and commerce; cleanup the environment and render the affected area safe; compensate victims; provide long-term mental health and other services to victims and the public; and restore a sense of well-being in the community.

# 5 Applying the Framework

The PSS Planning Scenario Framework was designed to meet the needs of a range of users to conduct planning, training and analysis. The framework was thus designed to characterize scenarios such that they could be selected, applied and analyzed based on the framework dimensions. To make effective use of the framework as a tool, it needs to function within a system. The conduct of this project involved the creation of the framework within MS Excel. The creation of a database fell outside the scope, and was thus initiated as a separate thrust.

The scenario framework was created using two separate Commercial off-the-shelf (COTS) tools: Mindjet Mind Manager and MS Excel. The first iteration, created in Mind Manager, allowed for several iterations of the framework to be created during brainstorming sessions. The final iteration is depicted in Figure 5. The scenario dimensions were also outlined in MS Excel as a single spreadsheet. The spreadsheet was created to facilitate the population of the framework with scenarios. The result was a repository of openly-available scenarios, characterized along the framework dimensions for selection and analysis.

## 5.1 Populating the Framework

Populating the framework involved two phases: collection of available scenarios, and characterization of scenarios along the framework dimensions. All scenarios used for this project were unclassified, though their application for planning and training limits their distribution. Over 90 scenarios and vignettes were characterized, with the sources of these scenarios varied from municipal governments to international organizations:

- International/Bilateral (e.g. CWID, DHS);
- Federal (e.g. DND, PSTP);
- Provincial/State (e.g. Wisconsin municipal government); and
- EM training institutions (e.g. JIBC, CEMC).

Each scenario was given binary association based on the dimension variables. For example, a scenario that included a national impact was assigned a “1”, but if it lacked any international impact, this variable was assigned a “0”. A cutout of the framework is included in Figure 10.[8]

[8] For a full version of the scenario repository used in this study, see the report authors or scientific authorities.

| Scenario Name | Source | Cluster | Criminal/Non-State | Foreign State | Social | Technical | Ecological | Weather-Related | G |
|---|---|---|---|---|---|---|---|---|---|
| Nuclear Detonation – 10-Kiloton Improvised Nuclear Device | DHS | Nuclear | 1 | 0 | 0 | 0 | 0 | 0 | |
| Biological Attack – Foreign Animal Disease (Foot and Mouth Disease) | DHS | Biological | 1 | 0 | 0 | 0 | 0 | 0 | |
| Cyber Attack | DHS | General | 1 | 0 | 0 | 0 | 0 | 0 | |
| Biological Incident - Pandemic Flu (for workshop) 23 Nov 07 | DRDC CSS | Biological | 0 | 0 | 0 | 0 | 0 | 0 | |
| Airplane Crash | Wisconsin EM | General | 0 | 0 | 0 | 1 | 0 | 1 | |
| Blizzard Emergency | Wisconsin EM | General | 0 | 0 | 0 | 0 | 0 | 1 | |
| Flash Flood-Public Information | Wisconsin EM | General | 0 | 0 | 0 | 0 | 0 | 1 | |
| Flood | Wisconsin EM | General | 0 | 0 | 0 | 0 | 0 | 1 | |
| Hazardous Material Accident-Ammonia Leak from Train Car | Wisconsin EM | Chemical | 0 | 0 | 0 | 1 | 0 | 0 | |
| Wildfire -Rural | Wisconsin EM | General | 0 | 0 | 0 | 0 | 0 | 1 | |
| Halifax Harbour Scenario | DRDC Atlantic | Chemical | 1 | 0 | 0 | 0 | 0 | 0 | |
| Windstorm | JIBC | General | 0 | 0 | 0 | 0 | 0 | 1 | |
| Traffic Accident/Chemical Spill | JIBC | Chemical | 0 | 0 | 0 | 1 | 0 | 0 | |
| Explosive Scenario #3 - Explosive Package on Public/Mass Transit | DRDC CSS | Explosives | 1 | 0 | 0 | 0 | 0 | 0 | |
| Explosive Scenario #5 - Munitions Attack on Transportation System | DRDC CSS | Explosives | 1 | 0 | 0 | 0 | 0 | 0 | |
| Explosive Scenario #6 - Large-Scale Fuel-Air Event in a Populated Area | DRDC CSS | Explosives | 1 | 0 | 0 | 0 | 0 | 0 | |

*Figure 10: Cutout of PSS Planning Scenario Framework*

Using a binary numbering of dimensions allowed the scenario characteristics to be manipulated and displayed graphically. The process of characterization generated a number of observations, revealing the subjective nature of how scenarios are developed and applied.

## 5.2 Observations

There were a number of initial observations after a cursory examination of the available scenarios. The observations were grouped based on the S&T Community dimension. The observations are derived from the initial population of the framework, but represent a reasonable sample. The only significant constraint was availability, thus limiting the scenarios to those that were not classified.

The data from the framework spreadsheet was manipulated to produce visual representation of related field, focusing on the primary dimensions of CoP, impact and time horizon. The results were processed using *Tableau*, a visualization tool.

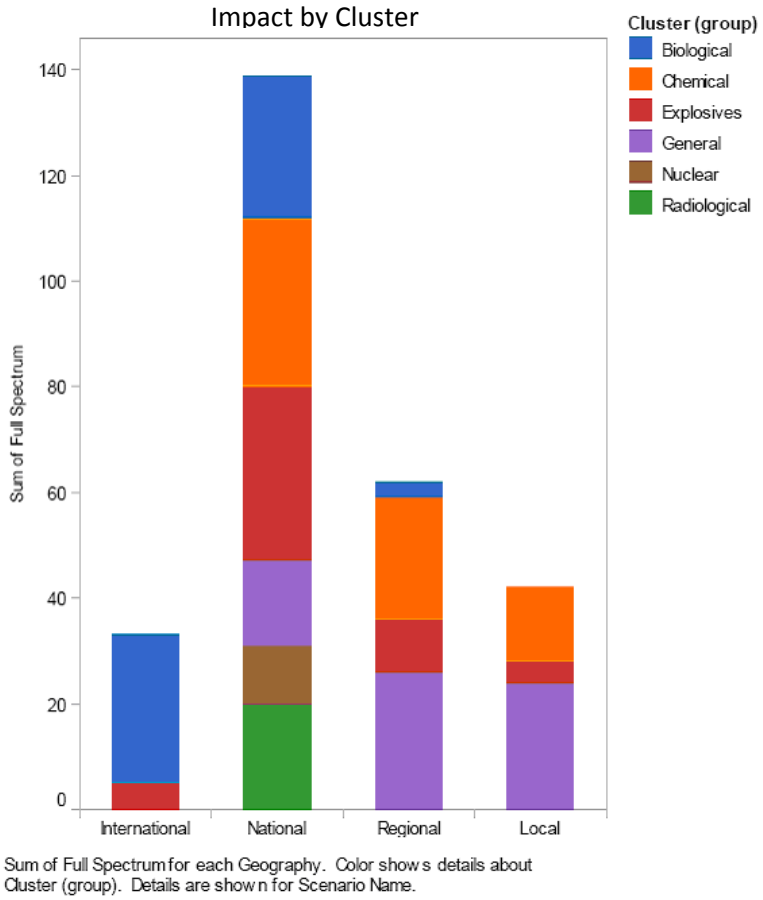


*Figure 11: Scenario Impact by CoP*

Based on the scenario sample reviewed, the histogram at Figure 11 depicts the breakdown of scenarios grouped by impact and CoP. By looking at impact, different classes of users can identify how many scenarios are focused only at the local, regional, national or international level. Radiological and nuclear events occur only at the national level as they are all classed as terrorist events. The complexity of the response requires a national effort. No biological scenarios are focused at the local level – most involve national and international factors.

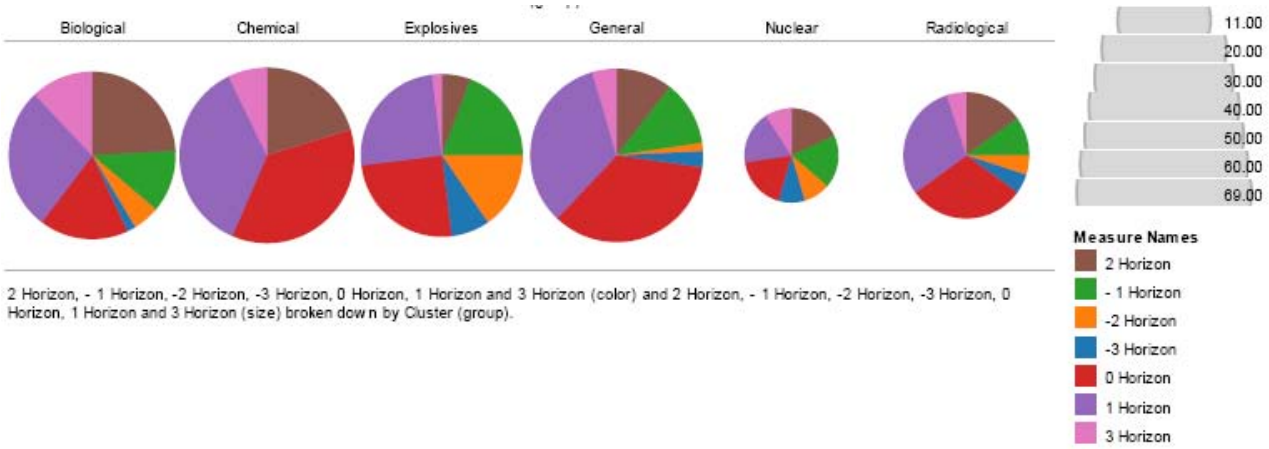


*Figure 12: Scenarios by CoP and Time Horizon*

The pie charts in Figure 12 provide a means for understanding the relative decomposition of the scenario set, and insight into how many full-spectrum scenarios exist for each CoP. The sum of the scenarios grouped by CoP is greater than the number of scenarios as many scenarios involve more than one CoP (e.g. radiological and explosive).The chemical and general scenario CoPs have the largest contingent of scenarios (over two-thirds of the scenario set each), with radiological and nuclear CoPs having the lowest (between 10 and 20 percent of the overall scenario set). The chemical CoP has no scenarios that cover the -3 to -1 time horizons, and there are few within the general and biological CoP.

*Chemical Scenario Observations:* The "chemical" category had the largest number of scenarios. This may reflect the frequency of occurrence (particularly compared against radiological or nuclear incidents), or could reflect the fact that, for training, chemical scenarios are geographically and temporally constrained. Chemical scenarios often require a level of detail to accommodate significant variances in chemical properties (e.g. lighter or heavier than air, exposure characteristics). Given their temporal nature, most chemical scenarios are limited to 0 to +2 time horizons, with the exception of chemical attacks that involve planning and acquisition phases.

*Biological Scenario Observations:* There were no available biological scenarios that addressed terrorist acquisition or planning of a biological agent. There was a balance of scenarios focused on naturally-occurring diseases (non-malicious) and intentional biological attacks (malicious), with a focus on consequence management (+1 to +3 time horizons). Pandemics had the farthest-reaching impact, existing at the national level at a minimum. Like the chemical scenarios, a mechanism needs to be included to allow for variances in agent/pathogen (e.g. transmission and infection rates and characteristics, morbidity and fatality).

*Radiological Scenario Observations:* In many respects, the response capabilities and mission areas invoked by radiological scenarios aligned with those for chemical events. The scenarios were all terrorist-driven, and thus the primary role of many scenarios was related to forensics (identification, classification and isolation of radiological material) and detection (i.e. border security).

*Nuclear Scenario Observations:* There were very few nuclear scenarios, most likely due to their low probability. All focused on terrorist events, and typically involved a broader spectrum of considerations of material acquisition, development, transport and detonation of a device. The impact considerations were also substantial, accounting for factors to the +3 time horizon. The lack of national-level planning scenarios for unintentional nuclear events (i.e. linked to a reactor incident) is the regionally-specific nature of such issues. Significant planning is conducted for the areas surrounding nuclear plants, including community preparedness through to response plans.

*Explosive Scenario Observations:* There were few explosive-only scenarios, with a number of scenarios incorporating explosions as a secondary effect or dispersion mechanism. There were no unintentional explosive events, despite their occurrence (e.g. the explosion of a propane plant in Toronto in 2008). The direct impact of explosive incidents is at the local or regional level, though any terrorist event can be described as having a national impact due to political implications.

*Other Scenario Observations:* All scenarios grouped in this category involved natural hazards. There were several, due to their frequency in occurrence. The scenarios typically did not include any forecast lead-up to an incident (i.e. weather tracking), leaving no ability to consider or exercise pre-positioning activities. Though not outlined within the set, minor natural hazards could be combined with other scenarios to generate secondary effects, such as adverse operating conditions or reduced access to resources due to weather-generated barriers.

## 5.3 Common Use

Scenarios are widely used to promote a shared appreciation of vulnerability and capability. On a higher level a scenario framework can be used to support development of a consistent set of metrics (comparing “apples to apples”) and to link lessons learned to plans and to decisions. On a lower level, Scenarios can be used to support mission analysis and decomposition into capability requirements and related tasks. Tasks in turn can be tied to conditions and standards - these can be measured and serve to make assumptions explicit. Tasks (assigned activities) are sequenced to establish processes. The advantages of agreeing conditions and establishing standards is key to Emergency Management unified command - in framing expectations for both organizational and common tasks.

## 5.4 Applying Scenarios – A Note of Caution

When applying scenarios, there are some limitations to be aware of. First, scenarios are predominantly told as a sequence of events, causally related to an apparently predetermined outcome or event. The danger lies in the cognitive model this creates. Decision-makers tend to use analogies in thinking about problems, and the event chain may bias thinking in associating a particular hazard with a scenario’s causal events. The resulting risk relates to over reliance on a narrow band of indicators that do not necessarily fit reality. Instead, an event may be caused by a combination of any number of underlying factors that align to produce the event. The real world is more akin to a complex system than a prescribed serial. Changes happen in parallel and intellectual allowance must be made for emergent behaviour and unanticipated effects. A graphical representation is included in Figure 13.

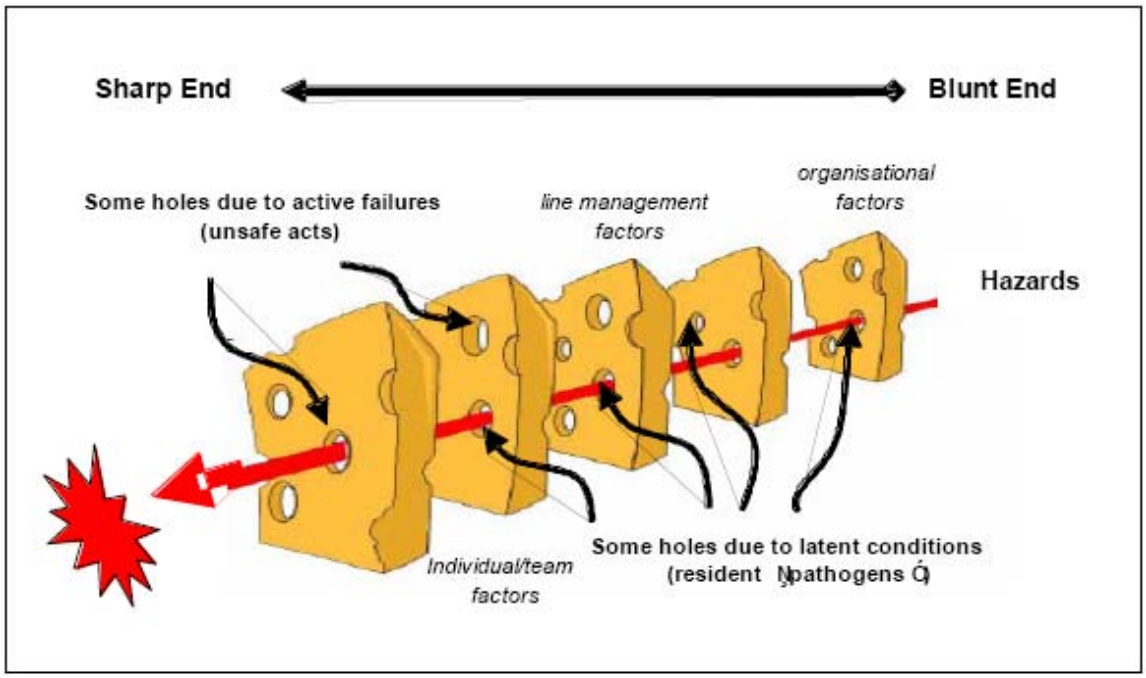


*Figure 13: Swiss Cheese Model of Defences (taken from Reason, 1997)*

To create scenarios that take into account the range of underlying factors, more comprehensive socio-technical models need to be applied. Arguably it is the human element which is most difficult to foretell and noteworthy that significant research is going into the development of cognitive and behavioural models. More sophisticated socio-technical scenarios would take significant time in development and would be difficult to apply as standardized scenarios, as the variables would be too diverse. However, such scenario modeling techniques merit investigation.

# 6 The Scenario Suite

The scenario set selected as a part of this project has two purposes. The first is as an illustrative example of how the framework can be applied. The second is more functional, as the scenario set is designed to support the evaluation of PSTP proposals within the scientific clusters of CBRNE. Its initial employment will be in support of innovation, such as S&T proposal evaluation. The scenario solution set provides an example of how to apply the framework for a specific user group. Proposal evaluation is based on an all-hazards approach. As a result, a representative full spectrum scenario was chosen for each of the clusters, as well as two additional scenarios involving smaller and larger scale natural hazards. PSTP proposal evaluators consider the full range of effects in addressing technological value added, in terms of mitigation/prevention, response and recovery. Hence the illustrative scenario set covers the entire time horizon (-3 to +3).

Where possible, the set makes use of pre-existing scenarios from the available body of work. For example, the radiological scenario is adapted from the DHS scenario set and placed within a Canadian context. One of the challenges in adapting pre-existing scenarios is achieving a consistent level of fidelity; that is, providing a common level of detail. In developing the context, every attempt was made to achieve a balance between creating scenarios broad enough to support PSTP proposal evaluation, and specific enough to support extension for use by other PSS stakeholders.

In each case, an effort is made to distinguish the major variables, as well as the origins of each scenario. Typically, common significant variables include demographic setting (e.g. urban or rural) and weather conditions.

The scenario set includes the following:

- Chemical: Chlorine Release
- Biological: Influenza Pandemic
- Radiological/Nuclear: IND explosion in downtown core
- Explosive: Explosion at international conference
- Other: Earthquake

A sample of one of the scenarios developed for the PSTP Symposium 2009 is included in Annex A.

# 7 Way Ahead

## 7.1 Framework Users

Any framework needs to serve the needs of the client base. The PSS Planning Scenario Framework is well-positioned to support the S&T community as well as other potential stakeholders involved in PSS policy, planning, training and operations. The framework dimensions are intended to evolve over time, based on new user requirements. Exposure is the first key. It is recommended that a communications plan be developed which would include active engagement through workshops and symposia.

### 7.1.1 Engaging the S&T Community

The framework and scenario set needs to be validated and tailored to meet the needs of the S&T community. The CBRNE Science Clusters were identified as the primary users. The framework was designed to support calls for proposals, serving to frame the evaluation of S&T proposals based on their ability to improve the capabilities invoked by a given scenario. In order to be applied to these calls the scenario set needs to be validated by SMEs to ensure that they adequately frame the problem space to the necessary degree of realism. The scenarios themselves, grouped according to CoP, are designed to be governed by these communities. The end goal is to Develop of a representative set of scenarios that frame risks flagged through robust risk assessments, capable of invoking capabilities across the -3 to +3 spectrum.

Other S&T portfolios should also be engaged to ensure a complete framework and scenario set. The development of scenarios that address challenges outside the CBRNE Science Clusters would support the development of a wider range of related capabilities and serve a larger audience. For example, the cyber and psychosocial CoPs would benefit from being included in future framework and scenario development. The cyber community faces a constantly changing environment of threats, comparable to the biological science cluster. Putting the rigour of science against the development of a set of full-spectrum cyber scenarios would aid SMEs in identifying the optimal areas for capability investment over all time horizons.

The framework is also well-suited to support research into major events security. In preparation for major events, there is a need to define roles and responsibilities across various departments and agencies, identify resource requirements and conduct training to familiarize all stakeholders prior to deployment. Scenarios are required for all of these activities. It is recommended that the framework be presented to the Major Events Coordinated Security Solutions (MECSS) team as a means to characterize a scenario set for major events operations.

### 7.1.2 Engaging the Operational Community

The focus of this project lay in developing a scenario framework. Scenario outlines reflecting Chemical, Biological, Radiological, Nuclear, Explosive and Natural hazards were proposed to illustrate framework application. The desirability of establishing a “baseline” scenario depicting a day in the life of public security was discussed. This fell outside the scope but merits serious

consideration as follow-on work. In addition to the inherent advantages accruing from documenting and developing a shared appreciation of existing roles, processes and support systems, two benefits are obvious. The first relates to realization and valuation of the enabling processes and technologies which support Command, Control, Communications, Computers, Information, Surveillance and Reconnaissance (C4ISR) activities. In the same way that scenario selection can bias response versus prevention initiatives unless the full spectrum is addressed, there is a danger of undervaluing enhancements to day-to-day routine operations.

The US Marine Corps characterizes battle rhythm as "the process where the commander and his staff synchronize the daily operating tempo within the planning, decision, execution and assessment (PDE&A) cycle to allow the commander to make timely decisions."[9] Outside the military, the term "Operational Tempo" offers a more appropriate descriptor. Developing a scenario illustrating the integration and orchestration of the daily, "whole of government" decision cycle would be useful for what drives many of the routine staffing activities This would also provide a backdrop and link to the other scenarios: a departure point for exploring crisis management implications and information management cycles.

### 7.1.3 Engaging the Training Community

The PSS Planning Scenario Framework has the ability to support trainers in the sharing and reuse of scenarios. Many first responders do not have the time or resources to engage in exercise design on an ongoing basis. The ability to search a repository of scenarios based on their own unique conditions would make for an effective use of resources. A mechanism should be put in place to ensure that validated planning scenarios are made available to the training community via a web-based service. An additional benefit to the use of common scenarios is the potential feedback that can be gathered through post-exercise reporting. By creating a method for documenting exercise lessons-learned (both positive and negative) against common scenarios can lead to the identification of areas for improvement and the development of best practices. A survey of training requirements and the development of a governance scheme are encouraged.

## 7.2 Framework Evaluation

Building on the framework observations, it is worth conducting a thorough analysis of existing scenarios to ensure completeness. Ensuring the full-spectrum scenario set addresses the spectrum of threats and hazards facilitates the development of a comprehensive evaluation of capabilities. One such approach to framework evaluation is Morphological Analysis (MA): "A method for structuring and investigating the total set of relationships contained in multi-dimensional, non-quantifiable, problem complexes". [24] Conducting MA would allow for identification of gaps in the scenario set based on a dominant set of dimensions (e.g. stimulus/trigger, time horizon, impact, CoP). Different iterations of MA, such as Field Anomaly Relaxation (FAR) and the Batelle Method, allow for the clustering of potential scenarios, and a ranking system based on probability. [25] This is a time-consuming process, but is a critical part of CBP. Such a process would allow for a degree of threat assessment and align with AHRA while contributing to a valid and complete set of full-spectrum scenarios. It is recommended that consideration be given to commissioning a study of scenarios through MA.

[9] Marine Corps Gazette. Vol 8, February 2001. pp34-36

## 7.3 Prototype Tool Development

The PSS Planning Scenario Framework was created to benefit users in accessing a set of full-spectrum scenarios. To serve this purpose, the framework needs to have the capability to search, present and access scenarios from a repository. It was decided that a web-based relational database be developed based on the framework. This work began as a part of a separate initiative, leveraging off the work completed in the development of this framework. The tool is currently in prototype form. It has the ability to compose scenarios based on multiple vignettes, and is being linked to databases created for conducting risk assessment. Current functions include visualization of scenarios as a Gantt chart and geo-referencing of scenarios. As the development of the tool was not complete at the time of writing, further discussion of functionality is premature.

Any progression of the PSS Planning Scenario Framework has the potential to impact the development of the tool. It is recommended that future tool development be conducted in tandem with the progression of the framework. Specifically, the development of user profiles and requirements should be conducted with current and potential stakeholders.

### 7.3.1 Proposed Areas for Development

While the current development plan for the prototype tool was informed by this project, such activities fell outside the scope of this project. Based on the findings of this project, future iterations of the relational DB should consider the following functions:

*Exercise Design and Management:* A plug-in to an exercise design and management tool would allow full-spectrum scenarios to benefit the training community. Such scenarios would need to be expanded to include information required for exercises, including weather, location, available resource status and location, and an outline of participant roles. Users would also require the ability to manage the execution of exercises through a Master Events List (MEL). There are already tools that can accommodate these requirements, including 4C Strategies' *Exonaut*.[10] It is recommended that the scenarios and database be configured to support such a tool.

*Lessons Learned Repository:* This type of framework, as it expands and evolves, is well-positioned to support a lessons learned database. Related to the exercise design and management functions, this repository would capture exercise feedback using scenarios. Such an initiative would need to address the information management challenge. While there is a desire to share as much information as possible, capability gaps are sensitive matter. As a result, it is recommended that lessons learned data exist through a separate database, allowing for greater security and anonymity. Through effective governance, lessons learned can be "sanitized" to an appropriate degree and disseminated as wide as possible.

[10] *Exonaut* is a web-based tool that facilitates the design and exercise of scalable exercises. It has been used for conducting NATO exercises as well as other exercises for PSS organizations and the telecommunications industry. For more information, see http://www.4cstrategies.com.

## 7.4 Support to Capability-Based Planning

In developing best practices a common set of standards is a desired objective. It allows for an understanding of readiness and can support improvement and investment plans. At the lowest level, it ensures a base understanding of capabilities of all partners and stakeholders to ensure optimal employment of generalist and specialist skill sets. The mission areas dimension is a proposed departure point for CBP. However, CBP for PS and EM in Canada requires the development of a common taxonomy of PSS capabilities and an associated set of capability metrics for scenario evaluation. A defined, measurable set of capability goals would allow effective planning and investment and promote standardization. These metrics should evolve from the local level with the evaluation and guidance from CoPs. It is recommended that a project be initiated to establish a set of capability goals to support CBP.

## 7.5 Scenarios and Simulation

To best take advantage of the PSS Planning Scenario Framework, it should be applied to simulation. The use of simulation for scenario-based planning, training and analysis contributes to rapid planning cycles, greater option analysis, as well as more interactive and cost-effective training environments. Simulation can help explore standards and conditions at a policy level by defining targets, and understand the effects at the operational level prior to their implementation. It is recommended that a scenario generation plug-in be developed for the PSS Planning Scenario Framework.

# 8 Conclusion

Scenarios are the context behind all facets of PSS. They serve to characterize threats and hazards, frame risks, and invoke the capabilities required for effective response. The PSS Planning Scenario Framework allows for both a risk and capability-based approach to planning. The framework allows the application of scientific rigour to the development of scenarios.

The development of the framework dimensions took into account threats and hazards, impact, time and capabilities. Its primary audience, the CBRNE CoPs, guided the development of many of these dimensions; the framework is well-positioned to evolve to accommodate future users and requirements. The training and major events communities all stand to benefit from a scenario repository. Many CoPs such as the psychosocial CoP study areas that cut cross several scenarios. By expanding and extending the framework, it stands to have far-reaching benefits for all of these users.

Populating the framework with available scenarios helped to generate a set of full-spectrum scenarios. The draft set, included in Annex A, has already been presented to the CBRNE CoPs, and stands to benefit from their input and feedback. The framework population also revealed the lack of existing full-spectrum scenarios; few scenarios were configured to evaluate the range of capabilities from prevention to recovery. The use of the -3 to +3 time horizons helps to characterize such scenarios, and could serve to guide the creation of others.

This framework has already contributed to the development of a prototype toolbox. The tools are at an early stage, but hold the potential to serve a variety of functions for the PSS and EM community. By including functions and plug-ins for exercise design and management, the capture of lessons learned, the toolbox could serve to reduce time and resources for training and contribute to the development of best practices. By linking the framework to simulation, these benefits are drastically increased through rapid planning and immersive training, as well as experimentation with potential future capabilities to drive investment efforts.

# References


[1] DRDC National Master Standing Offer Task 33BA03, “Planning Scenarios Development and Communication for Emergency Management and Systems Integration Application of Capability Based Planning Process”, Department of National Defence, 2008.

[2] Chouinard, P. Discussions with authors from October 2008 to June 2009, Ottawa.

[3] Paul K. Davis, Analytic Architecture for Capabilities-Based Planning, Mission-System Analysis, and Transformation, RAND, 2003.

[4] Alexander, David. “Scenario Methodology for Teaching Principles of Emergency Management”, *Disaster Prevention and Management,* Vo. 9 No. 2.

[5] Thomas Gross, “Building a Contingency Menu: Using Capabilities-Based Planning for Homeland Defense and Homeland Security”, *Homeland Security Affairs,* Summer 2005.

[6] Gill Ringland, *Scenarios in Business* (Chichester: Wiley, 2002).

[7] Jones, Trevor. “Advances in Risk Assessment for Australian Emergency Management”, *Australian Journal of Emergency Management* (Vol. 23 No. 4).

[8] Perla, Peter. “So a Wargamer and a Black Swan Walk into a Bar…”, *Phalanx* (Dec 2008).

[9] Sheldon Dickie, Cam Boulet and Susan McIntyre, “From Response to Prevention”, FrontLine Security, Issue 3, 2006.

[10] John Zachman, Enterprise Architecture Fundamentals Masterclass 2 December 2008.

[11] US Joint Forces Command, the Joint Operating Environment: Challenges and Implications for the Future Joint Force, 2008.

[12] Defence Research and Development Canada, “CRTI: Science Clusters”. Website. http://www.css.drdc-rddc.gc.ca/crti/clusters-grappes/index-eng.asp Last accessed 10 December 2008.

[13] Public Safety and Emergency Preparedness Canada, "An Emergency Management Framework for Canada". 2005. http://www.publicsafety.gc.ca/prg/em/_fl/emfrmwrk-en.pdf Last accessed 10 December 2008.

[14] Taken from the MORS Workshop on Risk-Informed Decision Making in Homeland Defense and Security, April 2009.

[15] BC Provincial Emergency Preparedness, “Hazard, Risk and Vulnerability Analysis Toolkit.” Web-based tool. http://www.pep.bc.ca/hrva/toolkit.html Last accessed 10 December 2008.

[16] Correspondences with Alain Goudreau, DRDC Centre for Security Sciences, Ottawa between November 2008 and June 2009.

[17] US Department of Homeland Security. *National Planning Scenarios.* 2005.

[18] Correspondences with Darren Blackburn, Justice Institute of British Columbia, Vancouver between November 2008 and June 2009.

[19] Goudreau, Alain. "Development of an All-Hazards Risk Assessment Model". Ottawa: Defence Research and Development Canada, 2008.

[20] Taken from TTCP Guidebook.

[21] Zahid Qureshi, "A Review of Accident Modelling Approaches for Complex Sociotechnical Systems", DSTO 2008.

[22] "In Search of Clarity", *The Economist Intelligence Unit*, 2007.

[23] Chris DeJager, "CRTI 05-0058TD Scenario Description", CAE Professional Services, 2008.

[24] Ritchey, Tom. "General Morphological Analysis: A General Method for Non-Quantified Modeling". Swedish Morphological Society, 2009. http://www.swemorph.com/ma.html. Last accessed 10 August 2009.

[25] Nguyen, M. –T. and M. Dunn. "Some Methods for Scenario Analysis in Defence Strategic Planning". Australian Defence Science and Technology Organization, February 2009.

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# Annex A PSTP Scenario Set

*The following scenario is extracted from a set of five scenarios presented to the PSTP Science Clusters 15 June 2009. This scenario was presented as a draft for discussion purpose only.*

## A.1 Scenario: Chemical Release at Rail Station

### A.1.1 Variables:

| Variable | Parameter |
|---|---|
| Stimulus/Trigger | Malicious, Criminal |
| Timeframe | Future |
| Context | Urban |
| Reference | Adapted from CRTI 05-0058TD, "Scenario Description", 2007. |
| Impact | Regional |
| Casualties | *TBD through SME consultation* |
| Psycho-social Consequence | *TBD through SME consultation* |
| CI consequence | *TBD through SME consultation* |
| Environmental Consequence | *TBD through SME consultation* |
| Economic Consequence | *TBD through SME consultation* |

### A.1.2 Scenario Overview:

It is a foggy fall morning in a *mid-sized Canadian city* at 8:35 am, *10° C with wind moving SSE at 4 kts*. A westbound passenger train bringing commuters into the city collides with a delivery truck at a railroad crossing. The crossing is clearly marked and fenced off by a chain link fence with a roller gate.

The train is carrying approximately *1250* passengers, and is travelling at 35 kms/hr at the time of the collision. The train's engine is at the back of the train pushing the cars towards the station. The impact occurs when a truck collides with the first of the nine passenger cars in the train. Six of the train cars are derailed with three of those rolling onto their sides. The train's engine continues to push forwards into the derailed cars. Some of the train cars burst into flames.

### A.1.3 Time Horizon -3: Community Knowledge (Preparation)

At this point, there is no sign of a chemical incident. However, a latent threat exists. The focus of this phase is on defining requirements and generating the capabilities which may be invoked.

Capabilities invoked within the -3 time horizon:

- **Risk Assessment** [TCL: Risk Management]:
    - **Threat/Hazard identification and analysis** [TCL: Planning]
    - **Identify groups with malicious intent** [TCL: Information Gathering and Recognition of Indicators and Warnings]:
    - **Develop risk modelling and analysis tools** [TCL: Risk Management]
    - **Evaluate access to knowledge and materiel**[TCL: Information Gathering and Recognition of Indicators and Warnings]
    - **Vulnerability assessment and consequence analysis** (e.g. effects on CIP) **[**TCL: Risk Management]
- **Conduct Strategic Planning** [TCL: Planning]
    - **Develop and validate Concept of Operations (CONOPs) and emergency plans** [TCL: Planning]
    - **Develop capability goals and response standards (e.g. communications procedures and protocols)** [Not specific to a TCL]
    - **Establish and maintain appropriate governance structure and regulatory regime** [Not specific to a TCL]

    - **Security measures for personnel and materiel**[TCL: Responder Safety and Health]

- **Build and Sustain Communities of Interest/Practice:**

    - **Share Information and Intelligence (e.g. catalogue of capabilities, collaborative databases)** [TCL: Intelligence and Information Sharing and Dissemination]

    - **Establish MOUs** [TCL: Planning]

    - **Expertise and laboratory capability** [TCL: CBRNE Detection]

Associated issues:

- Legislative control of sensitive or dual-use information across all media (e.g. internet)
- Established baseline Indicators and Warnings

### A.1.4 Time Horizon -2: Enforcement and Inspection

Again, at this point there are no definitive indicators of a chemical incident. The focus of this phase is on the routine employment of standing capabilities for the prevention of an event.

Capabilities invoked within the -2 time horizon:

- **Persistent surveillance of terrorist activities** [TCL: CBRNE Detection]

    - **Detection and inspections at border crossings** [TCL: CBRNE Detection]

- **Monitor access to controlled materiel (e.g. equipment and chemical substances)** [TCL: CBRNE Detection]

- **Training of general and specialist responders for chemical events** [TCL: WMD and Hazardous Materials Response and Decontamination]

Associated Issues:

- Considerations for surveillance and privacy issues

### A.1.5 Time Horizon -1: Focused Intelligence

There are no indicators of an event at this point in the scenario.

Capabilities invoked within the -1 time horizon:

- **Recognition of Indicators and Warnings** [TCL: Information Gathering and Recognition of Indicators and Warnings]
    - **Detection of chemicals and tracking (geo-referencing) movement of material** [TCL: CBRNE Detection]
- **Enhanced surveillance and protection/hardening of sector-specific CI and potential targets of interest** [TCL: Critical Infrastructure Protection]
- **Preposition of specialist response teams** [TCL: Critical Resource Logistics and Distribution]
- **Alert relevant peers and partners** [TCL: Communications]

Associated Issues:

- Alerting thresholds and protocols
- Mobilizing additional resources

### A.1.6 Time Horizon +1: On Scene Response

Within 1 minute of the collision, 911 is flooded with calls reporting the incident. Police, fire and EHS resources are dispatched to the scene immediately. Upon arrival, the local fire department sets up their command post and begin to evacuate the train, rescue the injured, and control the fire. The smoke-filled, foggy scene is chaotic.

The municipal police services set up their command post and quickly begin to establish perimeter security. Some passengers have self-rescued and are assisting fellow passengers. Other passengers, some injured, are wandering around the scene in shock.

Paramedics have established a triage station and have begun to treat the injured. The media has arrived and begins reporting. Curious bystanders are wandering around the site trying to see what's going on. All of this, plus the location itself, makes it extremely difficult for emergency vehicles to access the site. Traffic gridlock quickly ensues and traffic in the entire area comes to a standstill.

Ambulances have taken the injured to regional hospitals, which are quickly reaching capacity. Local transportation services are in the process of transporting uninjured passengers to an alternative location by bus.

**Note:** the lead agency should be identified as the scenario moves beyond the local level, particularly if terrorism is involved.

Capabilities invoked within the +1 time horizon:

- **Identification and classification of toxic material** [TCL: CBRNE Detection]

- **ICS and C2** [TCL: On-Site Incident Management]

Associated Issues:

- PPE for first responders

### A.1.7 Time Horizon +2: Specialized Response and Recovery

A Hazmat team is on the scene and is assessing for potential hazardous materials. A general evacuation of the area is in progress.

As Hazmat is investigating the truck they notice many canisters of *Chlorine (ID No. 1017, ERGO 2004).* An initial assessment determines there are *12 Canisters* of unidentified gas, canister type *XL-70HP*.

***FigureA-1:*** *XL-70HP*. ***Taken from*** *http://www.taylor-wharton.com/Pages/Liquid%20Cylinders/XL%2045HP-70HP.htm*

Each canister holds *260-280 litres*.

*Two of the seven* of the canisters are cracked, and one has split open.

The truck was heated during the fire and fire suppression activities have resulted in water passing through the compartment. The front corner of the trucks trailer section has been opened during the wreck.

Capabilities invoked within the +2 time horizon:

- **Area evacuation, shelter-in-place** [TCL: Citizen Evacuation and Shelter-In-Place]
- **Mass casualty decontamination** [TCL: WMD and Hazardous Materials Response and Decontamination]:
- **Situational awareness and consequence management**
    - Multi-agency interoperability [TCL: Communications]

- **Decision support**
    - **Course of Action development, simulation and analysis** [TCL: Emergency Public Safety and Security Response]
    - **Plume modelling** [TCL: WMD and Hazardous Materials Response and Decontamination]
- **Evidence preservation and specialized forensics** [TCL: Counter-Terror Investigation and Law Enforcement; CBRNE Detection]
- **Management of public information and messaging** [TCL: Emergency Public Information and Warning]

Associated Issues:

- Accreditation (e.g. licensing of medical countermeasures)

### A.1.8 Time Horizon +3: Recovery & Remediation

Post-event recovery includes an analysis of lessons-learned that is implemented at the -3 phase.

Capabilities invoked within the +3 time horizon:

- **Decontamination of affected area** [TCL: WMD and Hazardous Materials Response and Decontamination; Economic and Community Recovery]
    - **Preparation of recovery teams** (e.g. contractors) [TCL: WMD and Hazardous Materials Response and Decontamination]
- **Capture of post-event lessons-learned** [TCL: Planning; WMD and Hazardous Materials Response and Decontamination]
- **Long-term treatment and monitoring of medical surveillance data of exposed/affected personnel** [TCL: Economic and Community Recovery]

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# List of symbols/abbreviations/acronyms/initialisms

| | |
|---|---|
| DND | Department of National Defence |
| DRDC | Defence Research & Development Canada |
| DRDKIM | Director Research and Development Knowledge and Information Management |
| R&D | Research & Development |

**DOCUMENT CONTROL DATA**

(Security classification of title, body of abstract and indexing annotation must be entered when the overall document is classified)

1. ORIGINATOR (The name and address of the organization preparing the document. Organizations for whom the document was prepared, e.g. Centre sponsoring a contractor's report, or tasking agency, are entered in section 8.)

CAE Professional Services
300-1135 Innovation Drive
Ottawa, Ontario
K2K 3G7

2. SECURITY CLASSIFICATION (Overall security classification of the document including special warning terms if applicable.)

UNCLASSIFIED

3. TITLE (The complete document title as indicated on the title page. Its classification should be indicated by the appropriate abbreviation (S, C or U) in parentheses after the title.)

Public Safety Technical Program Planning Scenario Framework Final Report:

4. AUTHORS (last name, followed by initials – ranks, titles, etc. not to be used)

Hales, D; Race, P.

| 5. DATE OF PUBLICATION (Month and year of publication of document.) | 6a. NO. OF PAGES (Total containing information, including Annexes, Appendices, etc.) | 6b. NO. OF REFS (Total cited in document.) |
|---|---|---|
| Dec 2010 | 46 | 25 |

7. DESCRIPTIVE NOTES (The category of the document, e.g. technical report, technical note or memorandum. If appropriate, enter the type of report, e.g. interim, progress, summary, annual or final. Give the inclusive dates when a specific reporting period is covered.)

Contract Report

8. SPONSORING ACTIVITY (The name of the department project office or laboratory sponsoring the research and development – include address.)

Centre for Security Science (CRTI/PSTP)
Defence R&D Canada
222 Nepean St. 11th Floor
Ottawa, ON Canada K1A 0K2

| 9a. PROJECT OR GRANT NO. (If appropriate, the applicable research and development project or grant number under which the document was written. Please specify whether project or grant.) | 9b. CONTRACT NO. (If appropriate, the applicable number under which the document was written.) |
|---|---|
| | (NMSO# 24062-030150/001/ZG) |

| 10a. ORIGINATOR'S DOCUMENT NUMBER (The official document number by which the document is identified by the originating activity. This number must be unique to this document.) | 10b. OTHER DOCUMENT NO(s). (Any other numbers which may be assigned this document either by the originator or by the sponsor.) |
|---|---|
| DRDC CSS CR 2010-10 | |

11. DOCUMENT AVAILABILITY (Any limitations on further dissemination of the document, other than those imposed by security classification.)

Unclassified/Unlimited

12. DOCUMENT ANNOUNCEMENT (Any limitation to the bibliographic announcement of this document. This will normally correspond to the Document Availability (11). However, where further distribution (beyond the audience specified in (11) is possible, a wider announcement audience may be selected.))

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13. ABSTRACT (A brief and factual summary of the document. It may also appear elsewhere in the body of the document itself. It is highly desirable that the abstract of classified documents be unclassified. Each paragraph of the abstract shall begin with an indication of the security classification of the information in the paragraph (unless the document itself is unclassified) represented as (S), (C), (R), or (U). It is not necessary to include here abstracts in both official languages unless the text is bilingual.)

*Introduction:* Scenarios are critical to almost every aspect of Public Safety and Security (PSS) and Emergency Management (EM). Users within the stakeholder community, from policymakers to first responders, employ scenarios. They provide the context for requirements definition, options analysis and exercise design - characterizing the problem space, facilitating evaluation of response options and allow the introduction of new concepts and technology. To meet the needs of this diverse set of users, a framework has been developed to assist in selecting, sharing and exploiting planning scenarios. While the ultimate scope of application is much broader, the initial use of this framework is intended to support capability gap and options analysis as part of the Public Security Technical Program.

*Methodology:* The PSTP Planning Scenario Framework presented seeks to serve a range of stakeholders, from the national level to the community level in selecting scenarios based on user problems, objectives, risks and time. To develop the framework, there were three areas that needed to be addressed: a taxonomy for defining scenarios needed to be developed; dimensions for categorizing scenarios needed to be selected; and the framework itself needed to be populated with a selection of representative scenarios. Through a review of existing literature, a scenario was distinguished from alternate futures – long-term future trends – and from small, high-fidelity vignettes. For planning purposes, scenarios cover generic threats or hazards anticipated in the near future, including assumptions about context as well as capabilities. Each scenario within the framework was categorized based on a set of dimensions. These dimensions (including risk criteria, triggers, time horizons, etc) helped to define, access, and select scenarios.

*Way Ahead:* This project created a scenario set that has the potential to frame future S&T investment, through the PSTP, providing a common "yardstick" for evaluating S&T initiatives over time. The framework was also developed into a prototype relational database that could serve to provide greater access and use. Additional effort to mature the framework would help to promote scenario reuse and present a forum for capturing best practices and developing standards, thus improving efficiency and effectiveness of PSS and EM procedures from the community level up to national level.

*Introduction :* Les scénarios sont essentiels pratiquement pour tous les aspects de la Sureté et de la sécurité publique et de la gestion des urgences. Tous les utilisateurs au sein de la communauté des intervenants, des responsables des orientations politiques aux premiers intervenants, utilisent des scénarios. Ils établissent le contexte pour la définition des besoins, l'analyse des options et la conception des exercices – notamment en précisant le problème en cause et en facilitant l'évaluation des possibilités d'intervention, et ils permettent l'introduction de nouveaux concepts et de nouvelles technologies. Afin de répondre aux besoins de l'ensemble des divers utilisateurs, on a élaboré un cadre afin de faciliter la sélection, la communication et l'utilisation des scénarios de planification. Bien que le champ d'application final soit plus vaste, le but initial de ce cadre est de combler l'insuffisance en capacités et d'appuyer l'analyse des options dans le cadre du Programme technique de sécurité publique.

*Méthodologie :* Le cadre de création de scénarios de planification du Programme technique de sécurité publique (PTSP) soumis vise à aider une gamme d'intervenants, à la fois à l'échelle

nationale et à l'échelle locale, à choisir des scénarios en fonction des problèmes des utilisateurs, des objectifs, des risques et du calendrier. Pour élaborer ce cadre, il fallait effectuer les trois tâches suivantes : élaborer une taxonomie pour les scénarios de définition, choisir les scénarios de catégorisation et déterminer des scénarios représentatifs pour le cadre. En examinant la documentation disponible, on a distingué un scénario d'une gamme de scénarios possibles à l'avenir – les tendances futures à long terme – et de petites niches représentatives. Aux fins de la planification, les scénarios couvrent des risques ou dangers généraux prévisibles dans un proche avenir, y compris les hypothèses concernant le contexte ainsi que les capacités. Chaque scénario du cadre a été subdivisé en catégories en fonction d'un ensemble de dimensions. Ces dimensions (notamment les critères de risque, les éléments déclencheurs, les horizons temporels, etc.) ont permis de définir et choisir des scenarios ainsi que d'y accéder.

*Perspectives :* Le projet a permis de créer un ensemble de scénarios permettant de structurer l'investissement futur en S et T, dans le cadre du PTSP, en fournissant une référence commune pour l'évaluation des projets en S et T au fil du temps. Le cadre a été également présenté sous forme de base de données relationnelles prototype plus accessible et facile à utiliser. Des efforts supplémentaires pour améliorer ce cadre aideraient à promouvoir la réutilisation du scénario et offrirait un mécanisme de fixation des pratiques exemplaires et d'élaboration de normes, améliorant ainsi le rendement et l'efficacité des procédures de la Sécurité publique et de la gestion des urgences dans les collectivités locales et à l'échelle nationale.

14. KEYWORDS, DESCRIPTORS or IDENTIFIERS

Scenario; Vignette; Capability Based Planning; Risk